



# NUCLEAR SCIENCE ABSTRACTS

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# TABLE OF CONTENTS

Volume 15, Number 24A, December 31, 1961

<i>Category</i>	<i>Page</i>	<i>Category</i>	<i>Page</i>
GENERAL AND MISCELLANEOUS . . .	4111	METALS, CERAMICS, AND OTHER	
BIOLOGY AND MEDICINE . . .	4115	MATERIALS . . . . .	4184
General and Miscellaneous . . .	4115	General and Miscellaneous . . .	4184
Biochemistry, Nutrition, and		Corrosion . . . . .	4190
Toxicology . . . . .	4117	Fabrication . . . . .	4192
Fallout and Ecology . . . . .	4121	Properties and Structure . . .	4195
Radiation Effects on Living		Radiation Effects . . . . .	4203
Tissues . . . . .	4121	PHYSICS . . . . .	4205
Radiation Sickness . . . . .	4131	General and Miscellaneous . . .	4205
CHEMISTRY . . . . .	4134	Astrophysics and Cosmology . .	4212
General and Miscellaneous . . .	4134	Cosmic Radiation . . . . .	4212
Analytical Procedures . . . . .	4138	Criticality Studies . . . . .	4212
General Inorganic and Physical		Elementary Particles and	
Chemistry . . . . .	4143	Radiations . . . . .	4213
Radiation Chemistry and		Neutron Physics . . . . .	4216
Radiochemistry . . . . .	4149	Nuclear Properties and	
Separation Processes . . . . .	4155	Reactions . . . . .	4217
ENGINEERING AND EQUIPMENT . . .	4160	Particle Accelerators . . . . .	4226
General and Miscellaneous . . .	4160	Plasma Physics and Thermonuclear	
Heat Transfer and Fluid Flow . .	4162	Processes . . . . .	4227
Instrumentation . . . . .	4165	Theoretical Physics . . . . .	4238
Materials Testing . . . . .	4171	REACTOR TECHNOLOGY . . . . .	4242
GEOLOGY, MINERALOGY, AND		General and Miscellaneous . . .	4242
METEOROLOGY . . . . .	4172	Power Reactors . . . . .	4249
HEALTH AND SAFETY . . . . .	4175	Research Reactors . . . . .	4256
INDUSTRIAL APPLICATIONS OF		WASTE DISPOSAL AND	
ISOTOPES AND RADIATIONS . . .	4178	PROCESSING . . . . .	4258
ISOTOPE SEPARATION . . . . .	4179	CORPORATE AUTHOR INDEX . . . .	INDEX-1
MATHEMATICS AND COMPUTERS . . .	4181	PERSONAL AUTHOR INDEX . . . .	INDEX-7
		REPORT NUMBER INDEX . . . . .	INDEX-35
		SUBJECT INDEX . . . . .	INDEX-41







# NUCLEAR SCIENCE ABSTRACTS

## GENERAL AND MISCELLANEOUS

**31908** (ALI-C-61248) DEVELOPMENT OF A MEANS TO NEUTRALIZE INTENSE THERMAL RADIATION. Final Report. (Little (Arthur D.) Inc., Cambridge, Mass.). Oct. 31, 1960. Contract DA 19-129-QM-1087. 111p. (AD-255690)

Studies were carried out on the effectiveness of neutralizing radiant thermal energy incident on the outer layer of a clothing system by: expanding to form an insulative layer (foam formation); the attenuation of the radiation through the production of smoke or fog; and the utilization of heats of reaction, fusion, vaporization, and sublimation. The effectiveness of the materials and/or reactants is based on the quantity required to neutralize 5 and 10 cal/cm<sup>2</sup> of incident radiation. (B.O.G.)

**31909** (ARGMA-TN 2H1N-29) RESEARCH LABORATORY QUARTERLY RESEARCH REVIEW NO. 29, FEBRUARY 1, 1961-APRIL 30, 1961. (Army Rocket and Guided Missile Agency, Redstone Arsenal, Ala.). Aug. 1, 1961. 68p.

Progress on materials, nuclear physics, fuels and combustion, high-temperature physics, and solid-state physics is reported. (M.C.G.)

**31910** (BNL-671) NUCLEAR ENGINEERING DEPARTMENT PROGRESS REPORT, JANUARY 1-APRIL 30, 1961. (Brookhaven National Lab., Upton, N. Y.). Aug. 1961. Contract [AT(30-2)-Gen-16]. 73p.

Reactor Theory. Results are reported on the theoretical analyses of reactor experiments on: BNL slab water lattice experiments; the anisotropic neutron migration in uranium oxide, steel-clad, rod lattices; the Snell and Campbell-Poole experiments; Be-moderated critical experiments; and U-D<sub>2</sub>O lattices. Progress is reported on studies of: the physics of the HFBR; of settled-bed fuel reactors; gamma irradiation facilities; fast Pu-Bi solution reactors; high conversion ratio, thermal, Pu-fueled reactors; temperature coefficients in reactor<sup>2</sup> lattices; fission product poisoning; spatial Xe instability; and neutron thermalization. Experimental Reactor Physics.

Work was continued on the exponential and miniature slab and rod lattices, pulsed neutron experiments, and HFBR. Neutron Cross Section Evaluation. A general program for calculating fast neutron cross sections was developed.

Chemistry. Studies are continuing on the mechanism of solid state polymerization, on the kinetics of radiation-induced polymerization, and the mechanism of the radiolysis of aromatic compounds. Preparative-scale gas chromatography has been used for the purification of fluorocarbons. When C<sub>6</sub>F<sub>6</sub> was irradiated with Co<sup>60</sup>  $\gamma$ -rays in a Ni cell, the polymer yield ( $G_{\text{polymer}}$ ) was 2.6; this is about the same as the value found in a Pyrex cell although the gas yield in Ni was much smaller than in Pyrex. The thickness of 0.1- $\mu$  films between silica plates has been

measured approximately. Additional data have been obtained in the relative extraction coefficients of Na and Cs as ion association complexes and on the preparation of tetravalent uranium salts by precipitating uranyl sulfide. Chemical Technology. The x-ray diffraction equipment has been calibrated against Pt to 1500°C. Data have been taken for ThO<sub>2</sub> to 1500°C. Multicomponent Xe and Kr adsorption experiments were performed for concentrations from 0.025 to 0.93% and 0.025 to 0.10%, respectively, in a He stream maintained constant at 2000 cc/min. Adsorption in the multicomponent runs seems to be the same as observed with the respective single components. Experiments using the technique of equilibrating a graphite sample in a sealed capsule with iodine vapor and subsequent determination of the iodine concentration by wet chemical analysis have been completed. Work was begun with a technique using a sodium iodide scintillation probe to measure directly the concentration of I<sup>131</sup> tracer on a graphite sample. In the study of the ultimate disposal of high level waste, emphasis is being placed on the formation of phosphate glasses as a means of incorporating the fission products in stable media. Leaching studies with phosphate glass show they compare favorably with other glasses made with basically different composition. Data are presented on the production of carbon monoxide from carbon dioxide, the production of hydrazene aqueous ammonia, and on the polymerization of ethylene. In a series of four fluidized bed fluorination experiments, the recovery of U from an Al<sub>2</sub>O<sub>3</sub> bed was 98.4%. Chlorination of SS coupons was carried out within a static Al<sub>2</sub>O<sub>3</sub> bed in which the temperature difference between the central portion of the bed and the reactor wall was 75 to 175°C. No reaction between UO<sub>2</sub> and Cl<sub>2</sub> at  $\approx$ 700°C was noted. Studies were continued on development of the Nitrofluor process for recovering U and Pu from reactor fuel. The freezing and boiling points of the compound NOF·3HF were measured and the dissolution behavior of Zr and U in this compound was studied since it may be a constituent of high-boiling point fractions found in NO<sub>2</sub>-HF solutions. The existence of nonvolatile U residues following fluorination of the complex U salt produced during dissolution was investigated. The behavior of fission product fluorides in NO<sub>2</sub>-HF solution was examined using a U-fissium alloy as source material. Long-term corrosion tests on Monel specimens fully and partially immersed in NO<sub>2</sub>-HF solution at temperatures to 80°C showed very low corrosion rates. The root pass of welded specimens was as resistant as the base metal. Tests involving the addition of H<sub>2</sub>O to NO<sub>2</sub>-HF solution were studied. Work was conducted on development of the Phosfluor process, which involves fuel dissolution in anhydrous H<sub>2</sub>PO<sub>3</sub>F (monofluorophosphoric acid) and several alternate methods of process completion. Experiments were conducted to determine the diffusion of



Te in 2S Al using an Al-cylindrical, and Al-foil diffusion specimens. Released I and U were found in the cold zones after the meltdown of an irradiated U-Mo fuel, and showing that no definite I/U ratio exists. The percent I release is strongly temperature-dependent. Experimental evidence indicates that Ba<sup>140</sup> and La<sup>140</sup> are released independently.

**Engineering.** A project to study mass transfer and mixing phenomena in fused salt-liquid metal extraction columns is discussed. The chemical system to be used is the Bi-Mg-Zr-Ce/NaCl-KCl-MgCl<sub>2</sub> system. The distributing solute is Ce for which the distribution coefficient is known as a function of the concentration of Mg in Bi with good precision. Data are presented on experimental build-up factors in water from Co<sup>60</sup> slab sources. Heat transfer factors involved in shipping large quantities of Co<sup>60</sup> have been experimentally investigated using 83000 c Co<sup>60</sup>. A research irradiator has been constructed and tested. Construction is proceeding on the High Intensity Radiation Development Laboratory. A second series of runs was made with test element No. 2 in the new Hg heat transfer loop, located in the center of a 13-rod, unbaffled, rod bundle. A high-temperature loop is being built to determine heat transfer coefficients to alkali metals, under conditions similar to those being studied in the Hg loop. Empirical equations have been obtained, based on theoretical calculations, for expressing heat transfer coefficients for turbulent flow of liquid metals through concentric annuli, under different operating conditions. An experimental heat transfer research project has been started to obtain fundamental information on forced convection boiling and condensing of K, for the design of components for those auxiliary power plants for space vehicles which use alkali metals as working fluids. The maximum boiling temperature will be 1800°F, and the maximum vapor quality will be in the neighborhood of 50 wt%. **Hot Laboratory.** Isotopes development work performed on various aspects of eight isotopes is discussed. Research and development work in radiochemical analysis includes studies of: the extraction behavior of Th in the TTA-TOA system; the analysis of "fissium," a synthetic spent fuel element by emission spectroscopy and wet chemistry procedures; microwave excitation of samples for emission spectroscopy; the controlled-potential coulometric stripping of 900 ppm U from molten U-Bi in a fused chloride eutectic; a nitrate eutectic of the stable species of Cu in the presence and absence of Cl<sup>-</sup>; contact autoradiography of radioactive Ag electroplates; the adsorption of Te on alumina; the use of internal conversion x rays from a Cs<sup>137</sup> standard to standardize samples of I<sup>125</sup>; and a photometric method for determining the end point in the conventional Th titration. **Metallurgy.** Corrosion of materials by boiling Hg and Na is being studied. Corrosion and mass transfer in all-liquid Hg loops are being compared with these phenomena in boiling loops. An inert atmosphere welding chamber and an inert atmosphere loop operating chamber are being tested for their use in studying corrosion of refractory metals by boiling Na. Fe and Fe alloys containing less than 10 ppm each of C and O have been prepared by vacuum melting in MgO crucibles, holding the liquid just above the melting point of Fe, and cold trapping the vacuum chamber. The experimental technique for measuring release of fission gases from UBi<sub>2</sub> slurries in Bi was modified to eliminate effects of particle growth, and preliminary diffusion coefficients for Xe<sup>133</sup> out of UBi<sub>2</sub> at 800°C were obtained. Attempts to simulate fission concentrations in U metal by alpha-particle bombardment were not successful in producing reproducible results, possibly because of stringers of inclusions in the U metal.

The first of three fuel element tests for the HFBR has been irradiated to 40 to 50% burnup in ETR and is awaiting examination. The emf of the Fe-liquid Bi thermocouple has been measured in Bi containing 0.5 ppm Fe, and appears to be strongly influenced by the concentration of Fe in the Bi. An apparatus to measure quantitatively the diffusion of Fe in Bi and the effects of d-c currents on this diffusion is being tested. Carbide, nitride, and silicide particles in steels appear to be the least corroded by uninhibited Bi, as indicated by electron reflection-diffraction of the corroded surface of a steel specimen. The precision of the film formation techniques now being used has been determined; the number of specimens required to detect small effects with certainty appears to be prohibitively high. Liquidus curves of Bi with Hf, Pt, and Co were measured. Os, Ir, and Re were found to be difficult to alloy with Bi: Ir has a measurable solubility but is very slow in dissolving; Os and Re were not detected in Bi up to 600 and 500°C, respectively. The apparatus for measuring the magnetic susceptibility of liquid alloys has been determined to give the sensitivities required, to distinguish between Fe<sup>++</sup> and Fe<sup>+++</sup> in a 10 ppm Fe-Bi alloy and is now being built. The theory of metals is being modified to include certain p-type atomic orbitals, and the required calculations are being programmed for the BNL computer. Fission fragment tracks in Pt films from localized deposits of uranium oxide have been shown to have a periodicity of 207 Å from center to center of the vaporized regions, in agreement with the 200 Å calculated mean free path of a fission fragment between major collisions. The out-of-pile radiation loop has been removed from the reactor building and the samples examined metallographically without observation of corrosive attack. A failed (melted) fuel element from the Graphite Research Reactor showed evidence of U segregation throughout the failed plate. Effects of neutron irradiation and grain size on the low-temperature properties of as-received "pure" Fe have been measured. Graphite samples from the Graphite Research Reactor showed no stored energy release up to 650°C after the most recent reactor anneal, which occurred at temperatures above 300°C. Growth recovery of all samples checked for this anneal averaged 105% of the growth since the previous anneal. At 1400°C, the thermal conductivity of AGOT graphite specimens (placed in the pile in 1951) recovers 45 to 50% of its original value. Water soaking of graphite specimens, followed by vacuum drying at room temperature, appears to increase their oxidation rates by a factor of 1.1 to 3.3; no striking difference was found between those samples soaked and those ultrasonically cleaned. Preliminary diffusion coefficient calculations for Xe<sup>133</sup> out of uranium carbide powder have suggested the activation energy for diffusion to be approximately 32 kcal/mole. The corrosion in welded SS plates in the pilot plant dissolver, exposed to HNO<sub>3</sub>-HF solutions, was found to be caused by carbide precipitation in the heat-affected zones adjacent to the welds. Cb-stabilized SS welds were not corroded. An Al ultracentrifuge housing failed during operation by stress-corrosion penetration of Hg vapor condensing on the housing from a Hg electrical contact. A water-cooled graphite-tube resistance furnace has been built for the deposition of pyrolytic graphite from the pyrolysis of methane and it is possible to reach 3265°C. **Mechanical Engineering.** Developments are discussed for: the High Flux Beam Reactor project; the HFBR Fuel Handling Mock-up; the HFBR Critical Experiments; the HFBR Flow Reversal Test Loop; the Low Mass Critical Assembly; handling equipment for the Animal Tunnel in the graphite reactor; a mirror mount for the Arc Image Furnace; the



Slow Neutron Chopper; the NaK Heat Transfer Loop; Boiling Potassium Heat Transfer Loop; evaluation of Internal Pressurization for PWR application; the proposed High Temperature Critical Facility; the circulating system for the Chemonuclear Loop; components for the High Intensity Radiation Development Laboratory; Mark I Research Irradiator conveyor system; and the Mark II Research Irradiators. Reactor Evaluation. Studies of large power reactor systems utilizing settled fuels were initiated. The studies covered both thermal and fast reactor designs, and utilize alkali metals as coolant. Revision of the chemonuclear report on nitrogen fixation has been completed and studies of other chemonuclear systems such as for CO production are under way. The reactor coolant properties table has been completed and is ready for publication, as well as studies of internal pressurization and steam generator materials for PWR reactors. (B.O.G.)

**31911** (LA-2613) DETONATION PERFORMANCE CALCULATIONS USING THE KISTIAKOWSKY-WILSON EQUATION OF STATE. Charles L. Mader (Los Alamos Scientific Lab., N. Mex.). Jan. 1961. Contract W-7405-Eng-36. 20p.

A modified Kistiakowsky-Wilson equation of state is used to estimate the detonation performance of explosives composed of various combinations of carbon, hydrogen, nitrogen, boron, aluminum, oxygen, and fluorine. The computed velocities, pressures, and temperatures are compared with the available experimental detonation velocities, Chapman-Jouguet (C-J) pressures, and brightness temperatures. Over a wide range of density and composition the computed and experimental pressures and temperatures agree to within 20%, the detonation velocities to within 10%. The interrelationships between temperature, pressure, and the particle density of the C-J products as predicted by the Kistiakowsky-Wilson equation of state are discussed. (auth)

**31912** (NP-10830) THERMIONIC POWER APPLICATION FOR SPACE SYSTEMS. Status Report. Robert W. Pidd (General Atomic Div., General Dynamics Corp., San Diego, Calif.). [1961]. 5p.

Paper No. 2123-61 for presentation at American Rocket Society, Space Flight Report to the Nation/New York Coliseum, October 9-15, 1961.

The application and status of thermionic power conversion for space power was illustrated in terms of a system using a reactor heat source. Systems studies indicate a useful power output of 100 to 10000 kw(e). An application of the converter for lower power capacities uses solar heating with a solar collector to produce the high operating temperatures. (B.O.G.)

**31913** (NP-10835) STUDIES ON SURFACE AND UNDERGROUND NUCLEAR EXPLOSIONS. Final Report. M. A. Chaszeyka (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Feb. 28, 1961. Contract DA-44-009-ENG-3998. 264p.

The entire range of shock propagation, from the close-in phase to the elastic behavior, is studied. Under equation of state studies it is shown thermodynamically that the waste heat is the result of entropy changes and the absorption of thermal energy by the dense constituents in mixtures of solids and air. Fluid thermodynamic properties of a gas-solid mixture are studied. An analytical solution for a spherical shock wave with constant compressed density is presented. An analytical expression is derived for the acceleration behind a spherical shock wave and compared with experimental results. Cratering from surface and shallow-buried nuclear detonations is analyzed. The implications of

the radiation phase of a nuclear detonation on cavitation in a camouflat-type nuclear detonation are covered. High-explosive and nuclear detonations are analyzed on the basis of theoretical information and TNT field tests. Encouraging results are obtained for correlating high-explosive tests and nuclear detonations as bases for predicting nuclear detonation effects. A graphical general solution for refraction at an interface that overcomes obstacles posed for mathematical analyses of the problems is presented. This method is applied to a refraction at the earth's surface from a shallow-buried nuclear detonation. (auth)

**31914** (NP-10837) PROSPECTS FOR NUCLEAR ENERGY. (Shell International Petroleum Co. Ltd. Economics Div., London and Shell Internationale Research Maatschappij N. V. Nuclear Energy Div., The Hague). May 1960. 11p.

Prospects for economic application of nuclear energy are outlined. Topics covered include nuclear electricity generation, nuclear ship propulsion, nuclear process heat, and chemical applications. Some technical aspects of nuclear energy including nuclear fission, the uranium industry, military applications, nuclear reactors, and fusion are discussed. (M.C.G.)

**31915** (TID-3522 (Rev.5)) PEACEFUL USES OF NUCLEAR EXPLOSIONS. A Literature Search. Hugh E. Voress, comp. (Division of Technical Information Extension, AEC). Sept. 1961. 20p.

A literature search was made on Project Plowshare and peaceful uses of nuclear explosions. One hundred and forty nine references to report and published literature to October 1, 1961 are presented. (M.C.G.)

**31916** (UCRL-6510) SYSTEM OF AUTOMATIC PROCESSING AND INDEXING OF REPORTS. Lester Douglas Turner and James Henry Kennedy (California. Univ., Livermore. Lawrence Radiation Lab.). July 12, 1961. Contract W-7405-eng-48. 31p.

The rapidly increasing volume of new data in scientific and technical fields demands faster and better ways to communicate the new information to those concerned. A working system, System of Automatic Processing and Indexing of Reports (SAPIR), for doing this is described. SAPIR makes use of the Keyword-in-Context Index principle, by which certain keywords, together with surrounding words that act as modifiers, are selected from the titles of the technical publications. These keywords with their modifiers serve as index entries from each title, therefore, there will be as many index entries generated as there are keywords contained in the title. The index entries are sorted alphabetically by the keywords. The first letters of the keywords in each of the index entries form a column in the printed format, which makes scanning for the sought-after item easier. The SAPIR system is automatic and the list of citations is machine-generated on an IBM 1401 Computer. (auth)

**31917** (UCRL-6578) ON CRATERING: A Brief History, Analysis, and Theory of Cratering. Milo D. Nordyke (California. Univ., Livermore. Lawrence Radiation Lab.). Aug. 22, 1961. Contract W-7405-Eng-48. 77p.

Cratering is a subject that has been studied by many investigators for many years for many purposes. These purposes range from experimental studies of physical properties to large scale excavations using explosive charges of kiloton size. In the past ten years considerable effort has been devoted to cratering experiments for the purposes of determining the effects of cratering by nuclear explosions, with recent accent on Plowshare applications. From the large amount of data available for craters in alluvium it has

been possible to establish very reliable relationships between charge size, depth of burst, crater radii, and crater depths. In addition it has been possible to construct a preliminary theory of the mechanics of explosive crater formation. The available experimental data for nuclear and high explosive craters are reviewed, with particular emphasis on the data for desert alluvium, and the pertinent relationships are derived. A theory of the important cratering mechanisms, which has been evolved on the basis of these data and data from other sources, is outlined. (auth)

**31918** NUCLEAR EXPLOSIONS FOR PEACEFUL PURPOSES. William H. Berman and Lee M. Hydeman (Univ. of Michigan, Ann Arbor). *Nat. Resources J.*, 1: 1-22(Mar. 1961).

A general discussion is presented on the possibility of using nuclear explosions for preserving and facilitating the recovery of natural resources that are now being wasted or not fully utilized. Some discussion is also presented on the program (Project Plowshare) initiated by the United States to explore the peaceful uses of nuclear explosives. Other possible uses of the explosions are: excavation, preservation of water resources, and production of power. The major problems of foreign assistance through Project Plowshare are also discussed. (N.W.R.)

**31919** MOTION PICTURE FILM LIBRARY-PROFESSIONAL LEVEL, 16-mm. (Atomic Energy Commission, Washington, D. C.). Aug. 1961. 46p.

A list of 92 motion picture films with appended descriptions is presented divided into the following sections: power reactors, research and test reactors, fuels and processing, systems for nuclear auxiliary power, safety, physical research, biology and medicine, agriculture, industrial applications, miscellaneous subjects, and radioisotope series. Film title and producer indexes are included. (D.L.C.)

**31920** A SUMMARY OF NUCLEAR POWER RESEARCH AND DEVELOPMENT IN THE UNITED STATES. U. M. Staebler (U. S. Atomic Energy Commission, Washington, D. C.). p.3-14 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

A review of research and development is presented which includes an analysis of the contribution to the total development by selected reactor projects. It is noted that the entire development program of the U. S. is directed toward providing results which will make possible a more realistic evaluation of alternate nuclear and non-nuclear systems for particular applications, and, once selected, to build more nearly optimum nuclear plants for such applications. (J.R.D.)

**31921** PROCEEDINGS OF TECHNICAL MEETINGS. (Division of Technical Information, AEC). Oct. 1961. 56p. (ACCESS-101)

Abstracts and bibliographic information on meetings for which the USAEC has acted as sponsor, as a co-sponsor, or as a major participant during the past 15 years are presented. The information is arranged under the following headings: accelerators, biology and medicine, chemistry, computers, controlled thermonuclear reactions, education, general, heat transfer, hot laboratory practice, industrial hygiene, instrumentation, management, metallurgy and ceramics, nuclear safety, nuclear ship propulsion, physics, Plowshare program, radioisotopes and radiation effects, reactors, and waste processing. A subject index and a report number index are included. (M.C.G.)

**31922** SCIENCES IN COMMUNIST CHINA. A Symposium Presented at the New York Meeting of the American Association for the Advancement of Science, December 26-27, 1960. Sidney H. Gould, ed. Publication No. 68. Washington, D. C., American Association for the Advancement of Science, 1961. 883p. \$14.00.

Twenty-six papers are included on the development of science in Communist China. The papers are of the state-of-art type and are presented to improve communication to Western audiences of the results of scientific research conducted in China. The fields covered include the physical, biological, and social sciences and engineering. The results show that China will catch up with the Western world in the various fields covered in periods ranging from about five to fifteen years. This time period applies to basic research only. (N.W.R.)



# BIOLOGY AND MEDICINE

## General and Miscellaneous

**31923** (A/AC.82/G/L.585) DOSIS GENETICAMENTE SIGNIFICATIVA DEBIDA AL RADIODIAGNOSTICO MEDICO. Informe No. 49. (Genetically Significant Dose from Medical Radiodiagnosis. Report No. 49). A. E. Placer (Argentina. Comision Nacional de Energia Atomica, Buenos Aires). 1961. 19p.

A statistical study was made of the genetically significant dose received from x radiodiagnostics by the population of Buenos Aires between the years 1950 and 1959. The exposures were classified into type of exposure and sex. The minimum genetically significant dose received was calculated as 45 mrem/year. The possible increase in the dose received as a result of the increase in the number of x-ray examinations is discussed. (J.S.R.)

**31924** (ANL-6368) BIOLOGICAL AND MEDICAL RESEARCH DIVISION SUMMARY REPORT, JANUARY-DECEMBER 1960. (Argonne National Lab., Ill.). May 1961. Contract W-31-109-Eng-38. 216p.

Separate abstracts were prepared for 43 sections of this report. (C.H.)

**31925** (ANL-6368(p.48-50)) THE DNA SYNTHESIS TIME OF THE MYELOCYTE IN THE DOG. M. A. Maloney, C. L. Weber, and H. M. Patt (Argonne National Lab., Ill.).

The synthesis of deoxyribonucleic acid by myelocytes in dogs was studied by radioautographic analysis of bone marrow after the administration of tritiated thymidine. About 20% of myelocytes were labeled within 30 min after thymidine injection. (C.H.)

**31926** (ANL-6368(p.93-9)) STABILIZATION AND AUGMENTATION OF THE NEUTRAL DEOXYRIBONUCLEASE (DNase I) IN MAMMALIAN TISSUE. R. N. Feinstein and Ulrich Hagen (Argonne National Lab., Ill.).

Aqueous extracts of beef pancreas rapidly lose their DNase I activity upon incubation at 37°C. If albumin, peptone, or a variety of other proteolytic substrates is added to the extract, not only is there no loss of activity, but a severalfold increase in activity is observed. Mouse kidney or intestine, which normally show no DNase I activity, will exhibit an appreciable, though not great, activity if similarly incubated with albumin. Once-crystallized commercial DNase also loses activity upon incubation, but not in the presence of albumin or peptone. Protection against loss of activity in this system is presumably due to protection against denaturation. In the case of crude pancreas extracts, the protection is presumed due to proteolytic destruction of DNase inhibitor while DNase itself is protected from proteolysis. The complex formed between crystalline DNase and DNase inhibitor from mouse liver is dissociable upon dilution. (auth)

**31927** (ANL-6368(p.129-35)) STUDIES ON THE EFFECTS OF DEUTERIUM OXIDE. XI. EFFECTS OF ANTITUMOR DRUGS ON ASCITES TUMORS IN DEUTERATED MICE. A. J. Finkel, D. M. Czajka, and J. J. Katz (Argonne National Lab., Ill.).

Results of experiments with 5-fluorouracil and with 6-mercaptopurine indicated that an enhancement of antitumor activity was effected in mice with ascites tumors when partial deuteration of the organism accompanied the administration of the drug. Data are presented graphically. (C.H.)

**31928** (ANL-6368(p.149-51)) THE INTRACELLULAR DISTRIBUTION OF PHYTOCHROME IN CORN SEEDLINGS. S. A. Gordon (Argonne National Lab., Ill.).

Intracellular fractions of the corn seedlings were obtained by differential centrifugation. These were analyzed for phytochrome. The pigment protein was found associated with mitochondria as well as in the nonparticulate fraction. This association is discussed briefly in relation to the control of phosphorylation by red and far-red radiation. (auth)

**31929** (ANL-6368(p.156-8)) PHOTOPERIODIC RESPONSES OF SEQUOIA GIGANTEA SEEDLINGS. John Skok (Argonne National Lab., Ill.).

Observations on seedlings of *Sequoia gigantea* led to the conclusion that photoperiod does not influence cone formation in young seedlings but does markedly influence growth responses. Growth was depressed by short photoperiods and stimulated by long photoperiods. It was possible to increase the growth rate of *Sequoia* seedlings by extending the photoperiod in plants grown in the laboratory. (C.H.)

**31930** (ANL-6368(p.162-72)) PRELIMINARY STUDY OF CHEMICAL TESTS TO MEASURE THE REACTIVITY OF PEROXIDES. R. N. Feinstein (Argonne National Lab., Ill.).

A search was made for a test to classify peroxides according to chemical reactivity in the same order as their relative biological activity, with particular reference to their radiomimetic effect on the transforming factor. It was concluded that in the hydroquinone-peroxide system, disuccinoyl peroxide (DSP) behaves qualitatively differently from  $H_2O_2$  and cumene hydroperoxide (CHP), quinone being the primary product in the former case but being a very minor (if indeed existent) product in the latter cases. In all cases, metal catalyst (Cu or Fe) is required. If one observes only visible formation of color, one concludes that the order of reactivity is:  $H_2O_2 > CHP > DSP$ . In the reaction of peroxides with Dowex 1, the order of reactivity is evidently  $DSP > CHP > H_2O_2$ . In the release of free iodine from KI by peroxide, the order of reactivity is  $DSP \gg H_2O_2 \gg CHP$ . In the biological test of these three peroxides on the transforming factor, it was found that DSP is about  $10^4$  times as active as  $H_2O_2$ , while CHP was essentially inactive. It, therefore, appears that the third test above, i.e., release of free iodine from KI, is the only one of the three which puts these compounds in the same order as their biological effectiveness. (auth)

**31931** (ANL-6368(p.173-5)) ATTEMPTS AT CANCER THERAPY WITH CATALASE. R. N. Feinstein and Marilyn Vetter (Argonne National Lab., Ill.).

No evidence was obtained for a therapeutic action of catalase on rat or mouse tumors. Data are tabulated. (C.H.)

**31932** (ANL-6368(p.176-80)) 3-AMINO-1,2,4-TRIAZOLE. X. THE EFFECT OF CHEMICALLY MODIFIED AMINOTRIAZOLE ON ERYTHROCYTE CATALASE. R. N. Feinstein, Marilyn Vetter, and Carla Folkers (Argonne National Lab., Ill.).

Two chemicals, x-acetyl-3-amino-1,2,4-triazole (xAcAT) and 3-acetyl-amino-1,2,4-triazole (3AcAT) were tested as potential inhibitors of the catalase activity of intact erythrocytes. By analysis for 3-amino-1,2,4-triazole (AT)-like color, evidence was obtained that both the xAcAT and the 3AcAT are capable of penetrating the intact erythrocyte *in vitro*. (auth)



**31933** (ANL-6368(p.181-8)) THE CORRELATION OF AUTORADIOGRAPHIC GRAIN COUNTS AND TRITIUM CONCENTRATION IN TISSUE SECTIONS CONTAINING TRITIATED THYMIDINE. W. E. Kisielewski, Renato Baserga, and John Vaupotic (Argonne National Lab., Ill.).

Tritium-labeled thymidine is used extensively to investigate the kinetics of cellular proliferation in a variety of normal and pathological tissues. Procedures for the correlation of radioautographic grain counts and tritium concentration in tissue sections containing tritiated thymidine are discussed. Results are described from experiments which were performed in an attempt to establish a correlation between the number of developed silver grains in a stripping-film emulsion and the concentration of tritium in the labeled cells of an underlying tissue section. The total activity of tissue sections was measured in a liquid scintillation counter and results compared with the number of grains per section of radioautograms from the same tissue. Factors which may affect results are discussed. (C.H.)

**31934** (UCRL-9772) BIO-ORGANIC CHEMISTRY QUARTERLY REPORT, MARCH THROUGH MAY 1961. (California, Univ., Berkeley, Lawrence Radiation Lab.). June 29, 1961. Contract W-7405-eng-48. 121p.

Data from analysis and examination of meteorites Murray and Orqueil are presented. Results of an investigation to determine if there is a corresponding change in the conductivity of o-chloranil complex with perylene as a function of heating time are given. In studies of  $\pi$  bonding between the oxygen and the hetero atom in inorganic oxyacids and their anions, the methyl esters of nitric, phosphoric, and perchloric acids were studied to determine their proton-magnetic resonance spectra. Data on positions of chemical shifts for these esters in  $\text{CCl}_4$  are included. Results of a spectral study indicate that p-chloranil and p-bromanil dissolve in triethyl phosphite. The color produced in alcoholic solutions containing diethyl phosphonate, trinitrobenzene, and triethylamine is a chemical product and not a loose complex. Tests of strong bases with organic Lewis acids were conducted in which a large number of color reactions were found, supporting the suggestion that electron rearrangement to chemical products or inner complexes produces these colors. In a study of energy barrier to rotation about the sulfur-sulfur bond, synthesis of 7-ring disulfides is reported for study of an unexplained instability. A coupled reaction was investigated for use in estimating the Lexokinase (HK) activity in the rat brains. Data are tabulated for 15 brain areas. Oxidation of sorbitol and D-arabitol, adonitol, methyl D-ribosepyranoside, methyl- $\beta$ -L-arabopyranoside by the bacterium Acetobacter suboxydans is summarized. An improvement of steady-state apparatus and conditions for study of amino acid synthesis is reported along with methods of analyzing  $\text{N}^{15}$  labeled amino acids obtained from analysis at steady state. Design for a semiautomatic device for measuring radioactivity is described which operates by converting two-dimensional chromatograms into one-dimensional strips by cutting out the areas of paper bearing radioactive substances after these are located by radioautography, and mounting them between two continuous strips of thin plastic. (J.R.D.)

**31935** THE DESIGN OF A TREATMENT ROOM TO HOUSE A GANTRY-MOUNTED 4 Mev LINEAR ACCELERATOR. David Greene and Kenneth Stephenson (Christie Hospital, Manchester, Eng. and Holt Radium Inst., Manchester, Eng.). Brit. J. Radiol., 34: 640-7(Oct. 1961).

The logical development of an optimum design for a treatment room to contain a 4 Mev linear accelerator is

presented. Although the design was developed around a particular machine (the A.E.I. Orthotron), it is basically applicable to other comparable megavoltage x-ray units intended for treating large numbers of patients. Topics considered include access to the treatment room, patient viewing system, and detailed specification of protective barriers. (auth)

**31936** DETERMINATION OF THE APPARENT HALF-LIFE OF ERYTHROCYTES WITH RADIOACTIVE  $^{51}\text{Cr}$  IN VITRO. E. J. van Kampen and W. Heerspink (Diakonesenhuis, Groningen, Netherlands). Clin. Chim. Acta, 6: 630-6(Sept. 1961). (In English)

The uptake of sodium chromate- $\text{Cr}^{51}$  by normal erythrocytes was estimated in relation to the number of red cells per  $\mu\text{l}$ . It is shown that the  $\text{Cr}^{51}$  uptake in a hemolytic syndrome—not associated with an antigen-antibody syndrome—is always increased compared to the  $\text{Cr}^{51}$  uptake in the same number of normal erythrocytes per  $\mu\text{l}$ . This quotient—the Q-index—makes it possible to estimate the apparent half-life time *in vitro*. By means of partial hemolysis (pH-resistance) evidence was found that younger erythrocytes, especially reticulocytes, take up less  $\text{Cr}^{51}$  than older red cells. The elution theory, to explain the hyperbolic  $\text{Cr}^{51}$  disappearance curve in the *in vivo* estimation of the survival time of erythrocytes ( $t_A^A$ ), is thus superfluous. (auth)

**31937** NON-UNIFORMITY OF LABELLING RATE DURING DNA SYNTHESIS. Alma Howard and D. L. Dewey (Mount Vernon Hospital, Northwood, Middx, Eng.). Exptl. Cell Research, 24: 623-4(Sept. 1961).

Vicia faba root cells labeled with  $\text{H}^3$ -thymidine during the previous interphase appeared in division in two waves separated by time intervals of an hour or more. Experimental results are shown graphically. Two possible explanations for peaks in deoxyribonucleic acid synthesis are presented and discussed. (C.H.)

**31938** PROCEEDINGS OF A CONFERENCE ON BIOLOGICAL ASPECTS OF METAL-BINDING, HELD AT THE PENNSYLVANIA STATE UNIVERSITY, UNIVERSITY PARK, PENNSYLVANIA, SEPTEMBER 6-9, 1960. L. Audrey Johnson (Philadelphia General Hospital) and Marvin J. Seven, eds. Federation Proc., 20: Suppl. No. 10, Pt. II, (Sept. 1961). 284p.

A Conference on the Biological Aspects of Metal-Binding was held at The Pennsylvania State University, University Park, on Sept. 6 to 9, 1960. Discussions covered the physical chemistry of chelation, physiological aspects of metals, pharmacology and toxicology of chelating agents, and applications of chelating agents in medicine. An index of authors and discussants and a complete subject index are included. (C.H.)

**31939** MEASUREMENTS IN A TOTAL-BODY IRRADIATION FACILITY. A. C. Morris, Jr. (Oak Ridge Institute of Nuclear Studies, Tenn.). Intern. J. Appl. Radiation and Isotopes, 11: 108-13(Sept. 1961). (In English)

A  $\text{Cs}^{137}$  total-body irradiation facility for human patients has been in clinical operation at the Oak Ridge Institute of Nuclear Studies, Medical Division, since May 1960. Before that date measurements were made to determine the radiation parameters. Investigations were made concerning room backgrounds, radiation leakage from nearby teletherapy rooms, uniformity of the exposure field, exposure rates available for treatment purposes and spectral changes at different exposure rates. Rate measurements were made with an ionization probe; spectral data were obtained with a

scintillation crystal. Exposure rates are adjustable from 286 r/hr to 1.8 r/hr in thirty-two steps. (auth)

**31940** MODERN SOURCES OF HIGH-ENERGY IRRADIATION USED FOR TREATMENT OF NEOPLASMS (ACCORDING TO FOREIGN LITERATURE DATA). V. A. Petrov (Central Scientific Research Inst. of Medical Radiology, USSR). *Problems of Oncol.* (U.S.S.R.) (English Translation), 6: 1796-1812(1960).

A survey on sources for use in the high-energy irradiation of neoplasms led to the conclusion that high-energy electron beams have enormous advantages over x ray and  $\gamma$  therapy. Accessory devices for use with electron beams are described. (C.H.)

**31941** THE DESIGN AND CALIBRATION OF A DEUTERON MICROBEAM FOR BIOLOGICAL STUDIES. C. P. Baker, H. J. Curtis, W. Zeman, and R. G. Woodley (Brookhaven National Lab., Upton, N. Y. and Indiana Univ., Indianapolis). *Radiation Research* 15: 489-95(Oct. 1961). (BNL-5138)

An apparatus is described which administers known doses of protons, deuterons, or  $\alpha$  (alpha) particles in a beam as small as 0.025 mm in diameter to biological material. The energy is 11 Mev/nucleon. Penetration of the deuteron beam reaches a maximum depth of 2.3 mm, but the portion usable for radiobiologic analysis is confined to the first 1.5 mm of the track. (auth)

**31942** PHOTOSCANNING OF BONE LESIONS UTILIZING STRONTIUM 85. William H. Fleming, James D. McIlraith, and E. Richard King. *Radiology*, 77: 635-6(Oct. 1961).

Significant localization of  $\text{Sr}^{85}$  in bone occurs in fractures, metastatic cancer, eosinophilic granuloma, chondromas, osteomyelitis, and Paget's disease. Preliminary work indicates that photoscanning of bone lesions after the administration of  $\text{Sr}^{85}$  is practical and informative.  $\text{Sr}^{85}$  localization appears to occur only in areas of increased osteoblastic activity and is thereby an excellent means of evaluating this function of bone repair. Studies are reported in progress to assess bone scanning as a parameter of diagnosis and prognosis of skeleton lesions. (C.H.)

**31943** IMMUNIZATION TO SCHISTOSOMA MANSONI IN MICE INOCULATED WITH RADIATED CERCARIAE. John B. Villella, Henry J. Gomberg, and S. E. Gould (Univ. of Michigan, Ann Arbor and Wayne County General Hospital, Eloise, Mich.). *Science*, 134: 1073-4(Oct. 13, 1961).

Preliminary experiments indicate that mice inoculated with cercariae of *Schistosoma mansoni* that have been exposed to  $\text{Co}^{60}$  radiation in the range of 2500 to 3000 rep develop immunity to reinfection with nonradiated cercariae. (auth)

**31944** THE HEART IN DEEP THERAPY OF INTRATHORATIC TUMORS WITH SPECIAL CONSIDERATION OF TELECOBALT IRRADIATION. Rudolf Schneider (Universität, Marburg, Ger.). *Strahlentherapie*, 115: 366-78 (July 1961). (In German)

After a discussion of experiments on animals and clinical publications on heart damages or complications, preceded our own studies in which 309 patients with "intrathoracic blastoma" were observed are reported. Direct radiogen damage of the heart within the framework of radiation treatment does not often occur. On the other hand, there arise more often cardiac effects through the indirect action of the radiation (radiation pneumonitis, fibrosis, vegetative disorders, intrathoracic callosities, and scar formations). (auth)

**31945** METHODS FOR THE IMPROVED ADJUSTMENT OF THE DOSE DISTRIBUTION ON LOW-LYING DISEASE SITES IN MOVING FIELD IRRADIATION. Shinji Takahashi, Takashi Kitabatake, Kozo Morita, Shunzo Okajima, and Hiroyoshi Iida (Univ. of Nagoya, Japan). *Strahlentherapie*, 115: 478-88(July 1961). (In German)

The mode of action of the moving-field radiation of non-cylindrical and non-circular tumors as well as the shutting-out of the dose from the central region is described. With the help of these procedures the adjustment of the intensively radiated region succeeds even on the diseased focus of irregular shape. As practical examples the radiation of portio carcinoma and of hypophysis tumors are described in detail. (auth)

**31946** THE USE OF ISOTOPES IN HAEMATOLOGY. L. G. Lajtha. Springfield, Illinois, Charles C Thomas, 1961. 90p.

Applications of radioactive labeling in diagnostic and research studies in the field of hematology are described. Topics discussed include the labeling of plasma proteins for blood volume studies, the labeling of erythrocytes, measurements of the red cell life span, vitamin  $\text{B}_{12}$  metabolism, iron metabolism, white cell and platelet labeling, and applications of radioisotopes in radioautographs of blood samples. (C.H.)

**31947** DEHYDRATED VEGETABLES. Charles Watt Schroeder (to Unilever Ltd.). British Patent 874,752. Aug. 10, 1961.

A process is given for reducing the rehydration time of dehydrated vegetables by exposing them to gamma or beta radiation. The radiation energy should not be more than 10 Mev, and the dose should be  $0.25 \times 10^6$  to  $11 \times 10^6$  rep. Examples are given in which the process is applied to dehydrated carrots, green beans, celery, pepper, onions, cabbage, leek, lima beans, okra, potatoes, lentils, soup mixes, and sweet corn. (D.L.C.)

## Biochemistry, Nutrition, and Toxicology

**31948** (ANL-6368(p.33-4)) A FUNCTION FOR THE TISSUE MAST CELL. L. R. Draper and D. E. Smith (Argonne National Lab., Ill.).

Results of investigations on the function of tissue mast cells led to the conclusion that the mast cells may be of primary importance in initiating the inflammatory response accompanying antigen-antibody reactions. Data indicate that reactions depend, in part at least, upon the release of histamine and/or 5-hydroxytryptamine by the mast cells. The mechanism by which the release of the substances is brought about is not clear. (C.H.)

**31949** (ANL-6368(p.71-7)) THE UPTAKE AND RETENTION OF DIETARY STRONTIUM-90. M. P. Finkel, P. J. Bergstrand, and D. J. Graubard (Argonne National Lab., Ill.).

CBA mice of five age groups were provided with food containing radiostrontium, and their  $\text{Sr}^{90}$  content was determined by brehmsstrahlung counting. Animals started on the diet either at the time of conception or when they were 14 days old showed the greatest accumulation of  $\text{Sr}^{90}$ . However, their body burden increased very little, if at all, after 100 days. The rate of uptake decreased with increasing age at the time the special diet was first provided and also with increasing age as the animals remained on the diet. Mice



placed on the diet at 30 days of age or older contained significantly more  $\text{Sr}^{90}$  at 200 days than they had after being on the diet for 100 days, and it appeared that the normal life span of a mouse was not long enough to permit equilibrium to be attained. The retention of radiostrontium that had been supplied in the diet for over a month was followed in some animals that were returned to the standard food. Except for the exceedingly high retention among the mice that were 63 days old when normal food was provided, retention 2 weeks later was inversely related to age. Similarly, the excretion rates seemed to increase as the mice aged, except for the oldest animals, which were on the Sr diet between 150 and 183 days of age. The excretion rate for mice on a Sr diet from 30 to 63 days of age was calculated to be about  $t^{-0.21}$ . That for mice on the diet from 70 to 103 days of age was found to be about  $t^{-0.19}$ . These rates are much slower than the  $t^{-0.32}$  observed for 70-day-old mice after a single intravenous injection of  $\text{Sr}^{90}$ . (auth)

**31950** (ANL-6368(p.82)) CYTOCHROME C OXIDASE ACTIVITY IN AMOEBAE. J. F. Thomson and E. W. Daniels (Argonne National Lab., Ill.).

Homogenates of *Pelomyxa carolinensis*, *Pelomyxa illinoisensis*, and *Amoeba proteus* were assayed for cytochrome c oxidase to see whether there might be any correlation between the levels of this enzyme and the radiosensitivity of these amoebae. The results indicated that both species of *Pelomyxa* contained approximately the same amount of activity although their radiosensitivities differ by a factor of 10. *A. proteus*, the most radioresistant of the three species examined, had only one-tenth as much cytochrome oxidase activity as the two giant amoebae. This enzyme is extremely labile, its activity falling to about 10% of the original level in 40 min at room temperature. This lability is more marked in *P. carolinensis* than in *P. illinoisensis*. Since cytochrome c has not been found in amoebae, it is doubtful whether the enzyme was acting on a physiological substrate. Nevertheless it is clear that these organisms contain an enzyme capable of catalyzing the oxidation of molecular oxygen of reduced cytochrome c from mammalian sources. (auth)

**31951** (ANL-6368(p.110-14)) THE STUDY OF DIURNAL METABOLIC RHYTHMS WITH THE CONSTANT FEEDING TECHNIQUE. I. LIVER GLYCOGEN LEVELS AND DNA SYNTHESIS. R. W. Swick, G. Germek, and R. Ogawa (Argonne National Lab., Ill.).

Results are reported from a preliminary experiment in which liver glycogen levels and the incorporation of  $\text{P}^{32}$  into various chemical fractions of liver were determined at 6-hr intervals in rats fed continuously or hourly. Constant feeding appeared to dampen the cyclic changes in liver glycogen levels but had no effect on the rhythmic changes in the rate of synthesis of deoxyribonucleic acid. (C.H.)

**31952** (ANL-6368(p.119-22)) STUDIES ON THE EFFECTS OF DEUTERIUM OXIDE. IX. THE EFFECTS OF VARIOUS HORMONES AND VITAMINS ON THE SURVIVAL OF MICE MAINTAINED AT TOXIC LEVELS OF  $\text{D}_2\text{O}$ . D. M. Czajka, J. J. Katz, and A. J. Finkel (Argonne National Lab., Ill.).

Results are reported from studies on the effects of a number of hormones and vitamins on the ability of mice to survive toxic concentrations of deuterium in the body fluids. Thyroprotein, vitamin B mixture, vitamin  $\text{B}_{12}$ , thiamine, riboflavin, pyridoxine, calcium gluconate, nicotinamide, ascorbic acid, and vitamin K had a marked beneficial effect on survival time. A vitamin B mixture was more efficacious than any single vitamin. (C.H.)

**31953** (ANL-6368(p.123-8)) STUDIES ON THE EFFECTS OF DEUTERIUM OXIDE. X. CLINICAL COURSE OF DEUTERIUM INTOXICATION IN DOGS. D. M. Czajka, A. J. Finkel, C. S. Fischer, J. J. Katz, and B. M. Van Dolah (Argonne National Lab., Ill.).

Results are reported from preliminary investigations on the effects of deuterium oxide in dogs. Clinical laboratory data on deuterated beagles are tabulated. The most notable of these findings were unaltered white blood counts with relative lymphopenia and increase in polymorphonuclear leukocytes, hypoglycemia related to the degree of deuterium level in the body, electrocardiographic changes indicative of myocardial abnormality, and generalized muscular weakness. (C.H.)

**31954** (ANL-6368(p.136-9)) EFFECTS OF DEUTERIUM ON SOME ENZYMATIC REACTIONS. J. F. Thomson, D. A. Bray, and F. K. White (Argonne National Lab., Ill.).

Results are reported from studies on the effects of various concentrations of deuterium oxide on enzymatic reactions. Data are included on reactions with catalase, uricase, tryptophan pyrrolase, and malic dehydrogenase. (C.H.)

**31955** (ANL-6368(p.140-2)) EFFECT OF  $\text{D}_2\text{O}$  ON PLASMA VISCOSITY AND ERYTHROCYTE FRAGILITY. J. F. Thomson, F. K. White, and D. A. Bray (Argonne National Lab., Ill.).

Experiments in rats fed  $\text{D}_2\text{O}$  led to the conclusion that changes in kidney function observed in deuterated rats cannot be attributed to an increased viscosity of the blood. Deuteration had no effect on erythrocyte fragility, but erythrocyte production stopped completely in rats drinking 50%  $\text{D}_2\text{O}$  for 10 days. (C.H.)

**31956** (ANL-6368(p.152-5)) A NEW PATHWAY OF AUXIN BIOGENESIS. S. A. Gordon and L. G. Paleg (Argonne National Lab., Ill.).

A new pathway for the biosynthesis of plant auxin is described in which the degradation of tryptophan to indoleacetic acid is accomplished via polyphenolase systems. Reaction mechanisms are discussed. (C.H.)

**31957** (NYO-2375) METABOLIC STUDIES ON ETHIONINE AND DERIVATIVES. Final Report. Jakob A. Stekol (Inst. for Cancer Research, Philadelphia). [1958]. Contract AT(30-1)-1552. 6p.

Experiments are described in which ethionine was found to undergo metabolic activation (involving ATP) and act as the active ethyl donor group to appropriate acceptors. Observations from other experiments suggest that in animals receiving ethionine, S-adenosyl-ethionine will accumulate and that observed aberrations in such animals may stem from the interaction of ethionine with ATP. (J.R.D.)

**31958** (TID-13351) THE METABOLISM OF CARBON-14-LABELLED COMPOUNDS BY STAPHYLOCOCCUS AUREUS. Edward Steers (Pennsylvania. Univ., Philadelphia). July 28, 1961. Contract AT(30-1)-2040. 27p.

The carbon precursors of the polynucleotide purines and pyrimidines were determined for a strain of *S. aureus* by the addition of  $\text{C}^{14}$ -labeled nutrients added singly to a medium of known constitution. The results obtained were consistent with the precursors found for the purines of the pigeon, the rat, yeast, and other bacteria. Glycine, formate, and bicarbonate were found to be contributors of carbon, though only in the case of glycine were the specific activities obtained high enough to be unequivocal. Glucose, serine, and alanine also contributed carbon presumably via a prior conversion to  $\text{CO}_2$ , "1-C" units, and glycine, though here too the specific activities were very low. As in other



organisms, aspartate was found to be the principal precursor of the nucleic acid pyrimidines. Bicarbonate, glycine, and formate were also carbon contributors, though the specific activities obtained were not large enough to be unequivocal in meaning. The strain of *S. aureus* studied was found to be able to utilize exogenously supplied uracil for nucleic acid uracil synthesis and was found to be able to transform it into the other polynucleotide pyrimidines. Thymine was not utilized at all. Cytosine was utilized only slightly for polynucleotide cytosine synthesis. Exogenously available guanine and adenine could both be used for polynucleotide purine synthesis. However, while guanine could be converted into polynucleotide adenine, the reverse conversion took place only to a small extent. Both purines had an effect of the incorporation of the other purine when present in greater amount. Both purines were able to depress *de novo* purine synthesis. (auth)

**31959** (UCD-104) THE EFFECTS OF CONTINUAL  $\text{Sr}^{90}$  INGESTION DURING THE GROWTH PERIOD OF THE BEAGLE AND ITS RELATION TO  $\text{Ra}^{226}$  TOXICITY. Fourth Annual Progress Report. (California, Univ., Davis, School of Veterinary Medicine). Sept. 1961. Contract AT(11-1)-Gen-10. 126p.

Facilities and procedures for studying the effects of ingested  $\text{Sr}^{90}$  in beagles from zero ossification (in utero) to 18 months of age are described. A study of the retention of  $\text{Sr}^{90}$  with respect to Ca in beagles was made. Predictive equations for estimating the skeletal mass in living dogs are presented. Pathological consequences of administered  $\text{Sr}^{90}$  and  $\text{Y}^{90}$  were studied. (D.L.C.)

**31960** (UCLA-483) STUDIES ON THE BEHAVIOR OF RADIOZINC IN RAT PLASMA. J. P. Okunewick, B. Pond, and T. G. Hennessy (California, Univ., Los Angeles, School of Medicine, Lab. of Nuclear Medicine and Radiation Biology). July 21, 1961. Contract AT-04-1-GEN-12. 26p.

Studies were undertaken to determine the behavior of  $\text{Zn}^{65}$  when injected intravenously as the inorganic ion. A clearance curve for  $\text{Zn}^{65}$  similar to those reported by other workers was obtained. It was found that the decrease in clearance and distribution of  $\text{Zn}^{65}$  was not in direct proportion to the decrease in specific activity. Upon extraction of loosely-bound zinc from plasma with dithizone-acetone virtually all of the injected  $\text{Zn}^{65}$  could be removed up to one hour after intravenous injection. However, extraction of the unbound zinc ion demonstrated that more than 90% of the  $\text{Zn}^{65}$  is bound to protein within the first three minutes after addition of  $\text{Zn}^{65}$ . Dialysis of  $\text{Zn}^{65}$  against plasma protein showed the  $\text{Zn}^{65}$  ion is removed by plasma from solution by direct binding to non-dialyzable plasma components. Irradiation of rats with supralethal dosages of x rays followed by subsequent injection of  $\text{Zn}^{65}$  demonstrated that clearance of  $\text{Zn}^{65}$  from plasma is unaffected by the metabolic state of the animal. (auth)

**31961** (WRU-301) INTERMEDIARY METABOLISM OF CARBOHYDRATES AND RELATED SUBSTANCES. (Western Reserve Univ., Cleveland). Sept. 12, 1961. Contract AT(30-1)-1050. 20p.

Mechanism of Fixation of  $\text{CO}_2$ . Negative results were obtained for studies of the mechanism of acetyl CoA in the pyruvate carboxylase reaction. A co-factor was found which greatly stimulates the formation of fructose-6-P from fructose-1,6-diP at neutral pH but not at high pH. Role of Acetic Acid in Oxidation and Pentose Metabolism in Microorganisms. Studies were made which proved that an  $\alpha$ -hydroxyethyl substitute (HE) at position two of the thia-

zole ring of thiamin diphosphate (TDP) is the active intermediate in enzymatic reactions involving pyruvate and that diHETDP is the glycylaldehyde-TDP compound involved in transketolase. Oxidative Phosphorylation in Microorganisms. The active particles of yeast cells were separated by centrifugation and analyzed for their fatty acid content. The results support the hypothesis that unsaturated fatty acids are connected with the appearance of oxidative and phosphorylative abilities. (D.L.C.)

**31962** CALCIUM AND STRONTIUM SECRETION FROM BLOOD TO MILK. A. R. Twardock and C. L. Comar (New York State Veterinary Coll., Ithaca). *Am. J. Physiol.*, 201: 645-50 (Oct. 1961).

The mechanisms of Ca and Sr secretion from blood to milk in goats were studied using varying combinations of one radioisotope of Ca and two radioisotopes of Sr and continuous, long-term intravenous infusions as a means of maintaining desired blood levels of stable and radioisotopes of the two elements. Calcium and Sr secretion from blood to milk was the same whether radionuclides were given orally or intravenously; the same was true for radiostrontium excretion by the kidney. Stable Ca infusions gave plasma Ca levels as high as 36 mg %, causing marked decreases in blood and milk levels of ingested  $\text{Ca}^{45}$  and  $\text{Sr}^{85}$  and reduced renal Ca-Sr discrimination; these results are explainable in terms of a flooding of the renal tubule with stable Ca. Stable Sr infusion gave blood plasma and milk levels as high as 4.6 mg % and 39 mg %, respectively; it caused no change in blood and milk levels of ingested  $\text{Ca}^{45}$  but increased levels of ingested  $\text{Sr}^{85}$  by a factor of two. The relative movement of Ca and Sr from blood to milk was unaffected by infusions. After stable Ca infusions, plasma stable Ca consistently dropped below preinfusion levels; this may have been due to depression of the parathyroids by high blood Ca. After injection into the mammary gland via the teat canal, equal amounts of  $\text{Ca}^{45}$  and  $\text{Sr}^{85}$  moved into the blood stream, which indicated the existence of a unidirectional mechanism for preferential movement of calcium over strontium from blood to milk. (auth)

**31963** A SIMPLE RADIOISOTOPIC MICROMETHOD FOR DETERMINATION OF UNSATURATED IRON-BINDING CAPACITY OF SERUM. Norman D. Lee and Neil Chiamori (Bio-Science Labs., Los Angeles). *Clin. Chim. Acta*, 6: 624-9 (Sept. 1961). (In English)

A radioisotopic method for determining serum unsaturated iron-binding capacity is presented. Accuracy and precision comparable to chemical methods are obtained using 0.2 ml of serum. Hemoglobin at concentrations as high as 1% does not interfere and the method can be used in large scale routine application. (auth)

**31964** REMOVAL OF INTERNALLY DEPOSITED RADIONUCLIDES BY THE USE OF ESTERIFIED POLY-AMINOPOLYCARBONIC ACIDS. A. Catsch (Kernforschungszentrum, Karlsruhe, Ger.). *Intern. J. Appl. Radiation and Isotopes*, 11: 131-8 (Sept. 1961). (In German)

Based on certain assumptions concerning the mode of action of chelating agents, the effect of the esters of hydroxyethylethylenediaminetriacetic acid and bis(2-hydroxycyclohexyl)ethylenediaminediacetic acid on the behavior of radiocerium and radioyttrium in the organism of the rat was studied. Whereas the calcium chelates of the polyamino acids are ineffective, the esters, even given orally, induce a pronounced reduction of the radionuclide content of the liver. The radionuclides in this case are preferentially excreted with the feces. The effectiveness

of the esters depends largely on the time of the administration. The implications of the experimental findings are discussed. (auth)

**31965 DEUTERIUM ISOTOPE RATE EFFECTS WITH CITRATE-CONDENSING ENZYME.** George W. Kosicki and Paul A. Srere (Univ. of Michigan, Ann Arbor). *J. Biol. Chem.*, 236: 2566-70 (Oct. 1961).

The citrate-condensing enzyme was studied with  $D_2O$  and deuterioacetylcoenzyme A. The magnitude of the isotope rate effect ( $k_H:k_D = 1.4$ ), with deuterioacetylcoenzyme A, is independent of pH. The isotope rate effects of the forward and reverse reactions in  $D_2O$  are of different magnitude and are pH(pD)-dependent. When the isotope rate effect of the forward reaction reaches its maximum ( $k_{H_2O}:k_{D_2O} = 3.8$  at pH (or pD) = 7.5), there is no effect on the rate of the reverse reaction. In both the forward and reverse reactions, the isotope rate effects invert on the basic side of their pH(pD) curves. The observations are discussed in terms of shifted pK values of groups on the active enzyme-substrate complex. (auth)

**31966 EFFECT OF CRYSTAL GROWTH ON THE COMPARATIVE FIXATION OF  $Sr^{89}$  AND  $Ca^{45}$  BY CALCIFIED TISSUES.** R. C. Likins, A. S. Posner, Boris Paretzkin, and Ann P. Frost (National Inst. of Dental Research, Bethesda, Md. and National Bureau of Standards, Washington, D. C.). *J. Biol. Chem.*, 236: 2804-6 (Oct. 1961).

The deposition of injected  $Sr^{89}$  and  $Ca^{45}$  was compared in several different calcified tissues of the rat. The results showed that discrimination against strontium relative to calcium increased with an increase in crystallinity as determined by x-ray diffraction line broadening analysis. A range in size or perfection in the crystal texture, or both, of different calcified tissues was demonstrated. (auth)

**31967 PREPARATION AND PURIFICATION OF HUMAN INSULIN- $I^{131}$ ; BINDING TO HUMAN INSULIN-BINDING ANTIBODIES.** Solomon A. Berson and Rosalyn S. Yalow (Veterans Administration Hospital, Bronx, N. Y.). *J. Clin. Invest.*, 40: 1803-8 (Oct. 1961).

The preparation of  $I^{131}$ -labeled human insulin from a lot of human insulin containing approximately 25% insulin by weight and its purification from labeled contaminants are described. The reaction of human insulin- $I^{131}$  with insulin-binding antibodies in the serums of human subjects treated with commercial mixtures of animal insulins is demonstrated directly. Comparison of the binding of human insulin and beef insulin in antisera from eight insulin-resistant and nonresistant diabetic subjects revealed a lesser affinity of antibody for human than for beef insulin in most cases, but considerable variability in this respect was encountered among different antisera. (auth)

**31968 SKELETAL DYNAMICS IN MAN MEASURED BY NONRADIOACTIVE STRONTIUM.** Eugene Eisenberg and Gilbert S. Gordan (Univ. of California School of Medicine, San Francisco). *J. Clin. Invest.*, 40: 1809-25 (Oct. 1961).

Skeletal dynamics were calculated by usual dilution formulas, using stable strontium as a tracer, in 25 normal subjects, 14 athletes, 26 patients with postmenopausal osteoporosis, 28 with primary hyperparathyroidism, 3 with hyperadrenocorticism 8 with acromegaly, 7 with thyrotoxicosis, 11 with urolithiasis, 5 with Paget's disease of bone, and 1 with vitamin D poisoning. The technic requires that 10 mEq of strontium gluconate be injected intravenously and blood and urine concentrations be measured for 4 to 6 days. In normal subjects the rapidly miscible pool was equivalent to  $42.7 \pm 1.1$  L of serum, turning over at a rate

of  $13.5 \pm 0.6$  L daily, of which  $3.9 \pm 0.2$  L was excreted by the kidney and  $9.6 \pm 0.4$  L went to bone. Since only approximately 2.5% of the pool is excreted in the feces daily, fecal excretion was not measured routinely. Good reproducibility was found in 21 duplicate studies. Intense muscular exercise (athletes) was found to expand the pool greatly and to accelerate the rate of deposition in bone. Kinetically, two divergent types of osteoporosis were differentiated. A small pool and low rate of bone deposition were found in postmenopausal osteoporosis and Cushing's disease of long duration. The large pool and rapid rate of bone deposition in thyrotoxicosis was confirmed and also found in acromegaly. In these two, excessive bone resorption is postulated. Urinary excretion rate was excessive in Cushing's disease, thyrotoxicosis, and acromegaly. In hyperparathyroidism with clinically evident osteitis, expanded pools, greatly increased turnover, urinary excretion, and bone deposition rates were confirmed. In patients with normal roentgenographic appearance and phosphatase, bone involvement was shown by slight increase in bone deposition rate and microscopic foci of resorption on iliac crest biopsy. In seven patients without histological foci of resorption, the bone deposition rate was not increased. (auth)

**31969 THE INCORPORATION OF COPPER INTO CERULOPLASMIN *IN VIVO*: STUDIES WITH COPPER<sup>64</sup> AND COPPER<sup>67</sup>.** Irmin Sternlieb, Anatol G. Morell, Walter D. Tucker, Margaret W. Greene, and I. Herbert Scheinberg (Albert Einstein Coll. of Medicine, New York, N. Y.; Bronx Municipal Hospital Center, New York, N. Y.; and Brookhaven National Lab., Upton, N. Y.). *J. Clin. Invest.*, 40: 1834-40 (Oct. 1961).

The hypothesis that ceruloplasmin exchanges its copper for ionic copper *in vivo* was tested, by means of ceruloplasmin labeled with copper-64 and copper-67, in two patients with Wilson's disease and in two control subjects. No indication of exchange was found in any of three different experiments. It appears that copper is incorporated into the ceruloplasmin molecule *in vivo* only at the time of synthesis of the protein and not through exchange. A corollary of these results is that copper is a lifelong label of a ceruloplasmin molecule so that radioactive copper may be used for the determination of the turnover of ceruloplasmin and ceruloplasmin copper. The amount of copper incorporated daily into ceruloplasmin in a control subject corresponds closely to the amount of copper absorbed from the dietary intake. (auth)

**31970 THE PLASMA DISAPPEARANCE TIME AND CATABOLIC HALF-LIFE OF  $I^{131}$ -LABELLED NORMAL HUMAN GAMMA GLOBULIN IN AMYLOIDOSIS AND IN RHEUMATOID ARTHRITIS.** John A. Mills, Evan Calkins, and Alan S. Cohen (Harvard Medical School, Boston and Massachusetts General Hospital, Boston). *J. Clin. Invest.*, 40: 1926-34 (Oct. 1961).

The serum survival time and catabolic half-life of intravenously injected  $I^{131}$ -labeled pooled human  $\gamma$  globulin were studied in three patients with amyloidosis, four patients with rheumatoid arthritis, and three normal controls. The half-time of  $\gamma$  globulin survival in the control subjects ranged from 16.5 to 30 days. Two patients with amyloidosis, one primary and one secondary, both with the nephrotic syndrome, exhibited shortened serum half-times of 4.5 and 11 days, respectively. The serum half-time of the latter patient, before the appearance of clinical amyloidosis, was 14 days. One patient with primary amyloidosis but without nephrosis exhibited a half-time of serum  $\gamma$  globulin disappearance of 21 days. The half-time



of  $\gamma$  globulin disappearance in four patients with chronic active rheumatoid arthritis varied between 19.5 and 8.5 days. The lower figure was found in a patient having a high titer of rheumatoid factor. If this subject is excepted, the average half-time in three rheumatoid subjects is 17 days. The catabolic half-life of the iodinated  $\gamma$  globulin agreed in most instances with the serum half-time. The calculated distribution space of the injected  $\gamma$  globulin showed no consistent alteration in either amyloidosis or rheumatoid arthritis as compared with the control subjects. Since the nephrotic syndrome from other causes may produce an accelerated catabolic half-life, a similar finding on these subjects cannot be ascribed to amyloidosis. (auth)

**31971 CLINICAL PATHOLOGY AND BIOCHEMISTRY.** Donald F. Peterson (Los Alamos Scientific Lab., N. Mex.). J. Occupational Med., 3: No. 3, Special Suppl., 155-9 (Mar. 1961).

Data are tabulated on levels of serum enzymes, serum protease inhibitor, serum proteins, urinary catechol amines, urinary amino nitrogen, urine amino acids, urinary cysteine- $\text{H}_2\text{SO}_4$  positive material, urinary leucine aminopeptidase activity, and blood and urine levels of creatine and creatinine following exposure to lethal and sub-lethal doses of mixed neutrons and  $\gamma$  irradiation. (C.H.)

**31972 A BIOCHEMICAL EFFECT OF DEUTERIUM.** Howard J. Ringold, Sumner Burststein, and Ralph I. Dorfman (Worcester Foundation for Experimental Biology, Shrewsbury, Mass.). Nature, 191: 1294-5 (Sept. 23, 1961).

To test the hypothesis that *in vivo* certain compounds are oxidized in various degrees to the even more potent androgens, the 3-keto-5 $\alpha$ -androstanes, and that the 3-alcohols may be androgenically inactive *per se*, 3 $\alpha$ -deutero-17 $\alpha$ -methyl-5 $\alpha$ -androstane-3 $\beta$ , 17 $\beta$ -diol (I) prepared by the lithium aluminum deuteride reduction of 17 $\alpha$ -methyl-5 $\alpha$ -androstan-17 $\beta$ -ol-3-one (III), was assayed in the castrated rat in parallel with the corresponding 3 $\alpha$ -hydrogen-17 $\alpha$ -methyl-5 $\alpha$ -androstane-3 $\beta$ , 17 $\beta$ -diol (II). Compound II was found to be 3.36 times more active than the deutero-compound I on the basis of the ventral prostate and 4.65 times more active on the basis of response of the seminal vesicles, demonstrating that in the rat oxidation to the 3-ketone is an important, if not the sole, factor contributing to androgenicity of 3 $\beta$ -hydroxyandrostanes. In the chicks' comb assay, by local inunction, no significant difference was established between the activities of I, II, and III. (P.C.H.)

## Fallout and Ecology

**31973 RADIOACTIVE FALLOUT.** J. L. Mortensen (Ohio State Univ., [Columbus] and Agricultural Experiment Station, [Wooster, Ohio]). Agron. J., 53: 343-8 (Sept.-Oct. 1961).

An extensive monitoring and research program regarding fall-out is in operation all over the world. Concentration of fission products in the environment of man is being studied by air and precipitation sampling, gummed film collection, and analysis of soils, foods, animals, and man. The formation of fall-out during the explosion of nuclear devices, the fission products formed, the distribution of fall-out, the fate of fall-out in the soil, the passage of fall-out through the food chain, and processes of entry of fission products into animals and man are discussed. Data are tabulated on levels of  $\text{Sr}^{90}$  in the soil in the U. S. in 1959. (C.H.)

## Radiation Effects on Living Tissues

**31974 (A/AC.82/G/L.332) DEISTVIE IONIZIRUYUSHCHEI RADIATSII NA BAKTERIAL'NYE VIRUSY.** (Effects of Ionizing Radiation on Bacterial Viruses). G. E. Fradkin (Akademiya Meditsinskikh Nauk S.S.S.R.). 1959. 26p.

An analysis is made of the effects of ionizing radiation on genetic structures and related functions in bacterial viruses. The mechanism of the initial radiation effect on the nucleoprotein cell structure and the antigen properties of radio-inactivated bacteria-phagocytes are studied as well as the secondary radiation injuries and the feasibility of restoring the damaged biological structures. (R.V.J.)

**31975 (A/AC.82/G/L.631) DEISTVIE MNOGOKRATNOGO RENTGENOVSKOGO OBLUCHENIYA V MALYKH DOZAKH NA DEYATEL'NOST VYSSHIKH OTDELOV TSENTRALNOI NERVENNOI SISTEMY ZHIVOTNYKH.** (Effect of Repeated Low-Dose Exposure to X-Rays on the Activity of the Higher Sections of the Central Nervous System of Animals). L. E. Khozak (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii). Aug. 28, 1961. 24p.

Multiple, whole-body exposures of white mice to 0.5 r induced functional disturbances in the higher central nervous system. Twenty whole-body irradiations with 0.5 r resulted in cumulative radiation effects expressed eventually in complications of a reversible character. (R.V.J.)

**31976 (AD-255617) PROTECTIVE EFFECTS OF CERTAIN NATURAL FOODS AGAINST WHOLE-BODY IRRADIATION.** Report No. 8 (Progress) [covering] Period: July 15, 1960–October 14, 1960. William J. Darby (Vanderbilt Univ., Nashville. School of Medicine). Contract DA19-129-qm-1307. 10p.

In order to evaluate the protective effects of supplements of fat-soluble vitamins and of alfalfa an experiment was performed using guinea pigs maintained on Briggs diet, (Group A), local bran and oats supplemented with vitamin C (Group B), Quartermaster bran and oats supplemented with vitamin C (Group C), local bran and oats supplemented with fat-soluble vitamins and vitamin C (Group D), Quartermaster bran and oats supplemented with fat-soluble vitamins and vitamin C (Group E), local bran and oats supplemented with 20% alfalfa and vitamin C (Group F), and Quartermaster bran and oats supplemented with 20% alfalfa and vitamin C (Group G). After a feeding period of three weeks the following numbers survived: Group A-14, Group B-6, Group C-10, Group D-11, Group E-12, Group F-14, and Group G-13. The survivors were given 400 r (air dose) total body x irradiation. By the end of the twenty-first postirradiation day the only survivors were three animals from Group A and one from Group E. Nineteen Rhesus monkeys are being maintained on a complete purified diet in readiness for experiments in the immediate future. (auth)

**31977 (AD-255943) THE EFFECT OF IRRADIATION ON AUTOLOGOUS SKIN TRANSPLANTS.** Annual Progress Report, April 1960 to April 1961. Milton Elkin and Daniele Salvioni (Yeshiva Univ., New York. Albert Einstein Coll. of Medicine). Contract DA-49-007-MD-943. 14p.

Localized irradiation in sufficient doses prevents successful take of autologous skin grafts, apparently caused by direct effects of damage to the cells of the graft as well as to indirect effects of damage to vascular supply in the recipient bed. Experiments indicate that irradiation to the donor skin is more prejudicial to the success of the transplant than is irradiation to the recipient site. Autologous



split-thickness skin grafts were carried out on rabbits. X-irradiation was given to either the graft or the bed: 2200 r or higher to the donor skin prevented successful transplantation; 2145 r to the recipient bed showed no significant diminution in per cent of graft takes (87%) as compared to controls (92%); and 2860 r to the recipient site a number of grafts were successful (57%). With waiting periods of seven, fourteen and twenty-one days between irradiation and grafting, irradiated donor skin (2200 r) still failed to take. Administration of cysteine intravenously just before irradiation afforded some protection to the donor skin, there then being 48% successful takes. (auth)

**31978** (AF-SAM-61-94) EFFECTS OF RADIATION EXPOSURE ON RESPONSE LATENCIES OF RHESUS MONKEYS. A. A. McDowell, W. Lynn Brown, and James E. Wicker (Texas. Univ., Austin. Radiobiological Lab.). Sept. 1961. 4p.

Thirty-nine male and 25 female rhesus monkeys, ranging in age from 42 to 54 months, that were previously exposed to varying dosages of nuclear radiations, were tested in a modified version of the WGTA (Wisconsin General Test Apparatus) for 10 trials per day over a five-day period on response latency to a familiar food-rewarded wooden block placed randomly over either of the two outside food wells. They were then tested for 10 trials per day over a five-day period on response latency to either the same food-rewarded wooden block or to a non-rewarded wooden block presented simultaneously. The following results were obtained: on the single-stimulus-block condition, the higher the relative radiation dosage, the longer was the response latency; when the non-rewarded stimulus block was introduced, the higher the relative radiation dosage, the less was the disruption of response latency. (auth)

**31979** (ANL-6368(p.5-9)) ACUTE RADIATION MORTALITY IN THE PARAKEET. S. P. Stearner, S. A. Tyler, M. H. Sanderson, and E. J. Christian (Argonne National Lab., Ill.).

Dose-mortality curves for the parakeet exposed to  $\text{Co}^{60}$   $\gamma$ -radiation indicate that a linear reversal mechanism with a time constant of 287 min and an irreversible component with  $\text{LD}_{50}$  equal to 2310 r are the predominant injury processes operating within 30 days after irradiation. Radiation deaths rarely occur before the fourth post-irradiation day. These findings together with the similarity between time constants found for parakeet, chick, and chick embryo, suggest that the reversible process in the parakeet may be the same as corresponding processes expressed in the chick and chick embryo. Independence of injury mechanisms was assumed before a separation of effects could be accomplished in the parakeet. (auth)

**31980** (ANL-6368(p.10-11)) PROGRESS REPORT: FERTILITY OF CF NO. 1 FEMALE MICE IRRADIATED WITH FISSION NEUTRONS. D. L. Jordan and H. H. Vogel, Jr. (Argonne National Lab., Ill.).

Data are tabulated on the fertility of mice exposed to single, whole-body doses of 20, 50, 75, 100, and 150 rads of fission neutrons at approximately 5 rads/min. Results indicate that doses as low as 20 rads produce a significant decrease in both the number of pregnancies and in litter size. Complete sterility is produced at higher doses. (C.H.)

**31981** (ANL-6368(p.16-20)) LIFE SHORTENING IN MICE IRRADIATED WITH EITHER FISSION NEUTRONS OR  $\text{Co}^{60}$   $\gamma$ -RAYS AT LOW DOSE RATES. Howard H. Vogel, Jr., Norman A. Frigerio, and Donn L. Jordan (Argonne National Lab., Ill.).

Life shortening was compared in mice given 13 daily ex-

posures to fission neutrons or  $\text{Co}^{60}$   $\gamma$  radiation at dose rates of approximately 1 rad/min. Data are tabulated. Fission neutrons were 2 or 3 times as effective as  $\text{Co}^{60}$   $\gamma$  rays in reducing the life span by 50%. A comparison of data on reduction of life span after  $\gamma$  irradiation at a low dose rate with similar figures for a high dose rate indicates that the low intensity is much less effective in shortening the life span in mice. (C.H.)

**31982** (ANL-6368(p.21-6)) LACK OF ACQUIRED RADIORESISTANCE AFTER SINGLE DOSES (50 RADS) OF FISSION NEUTRONS OR  $\text{Co}^{60}$   $\gamma$ -RAYS. H. H. Vogel, Jr. and D. L. Jordan (Argonne National Lab., Ill.).

No evidence of acquired radioresistance was observed in mice exposed to 50 rads of either  $\gamma$  radiation or fission neutrons followed by exposure at intervals of 1 to 10 weeks to single midlethal doses of one of the two radiations. Data are tabulated on results of tests on sixteen groups each consisting of 24 to 32 young adult female mice. (C.H.)

**31983** (ANL-6368(p.27-9)) LONGEVITY OF FEMALE MICE IRRADIATED WITH SINGLE SUBLETHAL EXPOSURES OF FISSION NEUTRONS. H. H. Vogel, Jr. and D. L. Jordan (Argonne National Lab., Ill.).

Data on the life span of mice exposed to single sublethal irradiations with fission neutrons were analyzed. Results indicate a direct relationship between neutron dose and survival time and it appears that the total dose of fission neutrons is more important than the intensity in reducing the life span of mice. (C.H.)

**31984** (ANL-6368(p.30-2)) MAMMARY TUMOR INCIDENCE IN FEMALE SPRAGUE-DAWLEY RATS IRRADIATED WITH EITHER FISSION NEUTRONS OR  $\text{Co}^{60}$   $\gamma$ -RAYS. (Progress Report [for] 13 month period after first irradiation). H. H. Vogel, Jr. and D. L. Jordan (Argonne National Lab., Ill.).

A comparison was made of the incidence of mammary tumors in rats given four exposures at weekly intervals to either 100 rads of fission neutrons or 200 rads of  $\text{Co}^{60}$   $\gamma$  radiation. Data are tabulated. A direct relationship between tumor incidence and mortality was observed for each radiation. (C.H.)

**31985** (ANL-6368(p.35-42)) PROGRESS REPORT: DISEASES AND CARE OF LABORATORY ANIMALS. I. EFFECTS OF PSEUDOMONAS INFECTION OF MICE. R. J. Flynn, E. J. Ainsworth, and I. Greco (Argonne National Lab., Ill.).

*Pseudomonas* infections in mice interfere with radiobiological studies as well as other stress studies. *Pseudomonas*-infected mice also appear to be less resistant to other infections. Results are reported from a series of investigations on the diagnosis, epidemiology, and control of *Pseudomonas* infections in mice. (C.H.)

**31986** (ANL-6368(p.43-4)) DISEASE-FREE (PATHOGEN-FREE) BREEDING COLONY. R. J. Flynn and L. O. Bibbs (Argonne National Lab., Ill.).

Efforts to maintain disease-free rodent breeding colonies are described. Colonies have been achieved that are free of both endoparasites and ectoparasites and other commonly-occurring diseases such as salmonellosis. (C.H.)

**31987** (ANL-6368(p.45-7)) THE IMMUNE RESPONSE IN HIBERNATING ANIMALS. I. ANTIGEN DISAPPEARANCE IN HIBERNATING GROUND SQUIRRELS (*CITELLUS TRIDECIMLINEATUS*). B. N. Jaroslow and D. E. Smith (Argonne National Lab., Ill.).

The disappearance of  $^{131}\text{I}$ -labeled bovine serum albumin and of labeled squirrel serum from the circulation in hiber-

nating and non-hibernating ground squirrels was measured. Although little or no disappearance of homologous or heterologous proteins from the circulation was observed in hibernating animals, it appeared that some of the events that occur during the induction period transpired while the ground squirrels were hibernating. (C.H.)

**31988** (ANL-6368(p.51-5)) **RADIOSENSITIVITY OF THE HYPERTROPHYING MOUSE KIDNEY.** R. L. Straube and H. M. Patt (Argonne National Lab., Ill.).

Results of studies on the desoxyribonucleic acid content of the residual kidney 5 to 6 days after unilateral nephrectomy and the effects of local kidney x-irradiation after uninephrectomy on renal compensation indicated that the compensatory response which occurs after unilateral nephrectomy in the young adult mouse is relatively radio-resistant. These studies emphasize the relative insensitivity of a hypertrophying organ to radiation effects. (C.H.)

**31989** (ANL-6368(p.56-60)) **PRELIMINARY RESULTS FROM THE MONTE CARLO STUDY IN THE STOCHASTIC THEORY OF MORTALITY.** G. A. Sacher and E. Trucco (Argonne National Lab., Ill.).

The stochastic theory of mortality in its present stage of development deals exclusively with those aspects of the mortality process which are probabilistic in the sense that the occurrence of a lethal event is governed by chance alone. A simplified model is presented and preliminary results are reported from a Monte Carlo study of the theory. (C.H.)

**31990** (ANL-6368(p.61-3)) **PROGRESS REPORT: ON THE FOKKER-PLANCK EQUATION IN THE STOCHASTIC THEORY OF MORTALITY.** E. Trucco (Argonne National Lab., Ill.).

Applications of an equation of the Fokker-Planck type to describe random fluctuations of physiological variables in applications of the stochastic theory to studies on mortality are discussed. Certain revisions in the equation are suggested. (C.H.)

**31991** (ANL-6368(p.104-6)) **STUDIES ON THE ACID PHOSPHATASE AND  $\beta$ -GLUCURONIDASE ACTIVITIES OF THYMUS AND SPLEEN AFTER WHOLE-BODY X-IRRADIATION OF RATS, AND THEIR POSSIBLE RELATION TO THE LYSOSOME PARTICLES.** Y. E. Rahman (Argonne National Lab., Ill.).

The specific activities of both acid phosphatase and  $\beta$ -glucuronidase in spleen and thymus were increased after exposure of rats to whole-body irradiation. The significance of the increase of enzyme activities as well as their relation to lysosome particles was investigated in thymus tissue and fractions separated by density-gradient centrifugation examined under the electron microscope before and after irradiation. Results are summarized in tabular form. (C.H.)

**31992** (ANL-6368(p.115-18)) **DENSITY GRADIENT CENTRIFUGATION. EFFECT OF X-RADIATION ON DISTRIBUTION OF CYTOPLASMIC PARTICULATES OF RAT LIVER.** J. F. Thomson, Y. E. Rahman, and F. K. White (Argonne National Lab., Ill.).

No clear-cut effect of radiation on rat liver mitochondria was demonstrated in tissue samples prepared by gradient centrifugation and assayed for enzymatic activity. Data are presented on the distribution of succinic dehydrogenase and uricase as a function of particle size in liver homogenates from control and irradiated rats. (C.H.)

**31993** (ANL-6368(p.143-6)) **ENERGY TRANSFER IN PHOTODYNAMIC ACTION.** D. E. Smith, Leonida

Sanamaria, and Bernard Smaller (Argonne National Lab., Ill.).

Electron spin resonance spectroscopy was used to study photodynamic action in a model system in an attempt to determine whether free radicals might constitute some of the intermediates in the transfer of energy in photosensitized oxidation. The model system used consisted of hematoporphyrin as the sensitizer and human blood serum as the substrate in phosphate buffer at pH 7.3. A high-pressure mercury arc was used as a light source and irradiations were carried out at  $-20^{\circ}\text{C}$ . Results indicate that hematoporphyrin in the triplet state can combine with oxygen to form an oxyradical which may then react with the substrate. It was concluded that the  $-20^{\circ}\text{C}$  state allows the operation of a useful model system of photodynamic action. (C.H.)

**31994** (ANL-6368(p.147-8)) **TYPES OF CHROMOSOME BREAKS PRODUCED BY COLCHICINE AND X-RAY IN COLLINSIA HETEROPHYLLA.** E. D. Garber (Argonne National Lab., Ill.).

A significant difference was found between reciprocal translocations in Collinsia heterophylla resulting from colchicine treatment or x irradiation of seeds and apical meristems. Experimental results indicate a difference in the site of chromosome breakage. Observations and their explanations are presented which will be used as a basis for exploring the chromosomes of this species in terms of their response to irradiation with different ionizing sources and to chemical mutagens which are radiomimetic. (C.H.)

**31995** (ANL-6368(p.189-99)) **DNA SYNTHESIS OF MAMMALIAN KIDNEY CELLS IN TISSUE CULTURE AFTER SINGLE AND PERIODIC DOSES OF IRRADIATION.** A. N. Stroud, A. M. Brues, and B. R. Svoboda (Argonne National Lab., Ill.).

The effect of irradiation upon the uptake of tritiated thymidine by cells *in vitro* was investigated, employing a pig kidney cell and a monkey kidney cell strain. The two strains exhibit marked differences in thymidine uptake both in the unirradiated state and after irradiation. Thirty to forty % of the pig cells incorporate thymidine and this rate of incorporation continues for several days after subcultivation; after irradiation, the extent of thymidine incorporation is reduced in relation to the x-ray dose (between 200 and 1000 r). Only a small percentage of monkey cells incorporate thymidine except for a period in the first day of subcultivation which may represent a period of synchrony or of recovery from injury of handling; on the other hand, these cells are proliferating at about the same rate as the pig cells. When the monkey cells are irradiated, they show a sharp increase in the percentage of labeling, which continues for several days. It is suggested that normal DNA synthesis in the monkey cells involves some alternate pathway of DNA synthesis not utilizing exogenous thymidine, but a *de novo* synthesis of DNA, and that a radiation-induced block of that pathway results in utilization of the labeled thymidine by the cells. The pig cells are diploid and the monkey cells are sub-tetraploid. The pig cells are more radiosensitive, perhaps on this account; cultures of these cells fail to grow after a second irradiation with 500 r while the monkey cells grow well after three such irradiations. Alternative explanations of the differences in radiosensitivity are under consideration. (auth)

**31996** (ORNL-TM-29) **INFLUENCE OF RADIATION FROM AN UNSHIELDED REACTOR ON A NATURAL**



**MICROFLORA.** Martin Witkamp (Oak Ridge National Lab., Tenn.), Oct. 19, 1961. Contract W-7405-eng-26. 9p.

The soil microflora and its respiratory activity were measured in soil cores collected at different distances from an unshielded reactor. No direct correlation was found between dose received and microbial counts or respiration. Indication of a correlation between dose and microbial respiration was obtained after eliminating the overriding influence of moisture. Radiation probably affected the soil microflora through damage to the phanero-gam vegetation rather than directly. This preliminary study indicates the need to have undisturbed sampling areas close to the ORNL fast burst reactor. Extensive dosimetry, both in and above the soil, in these areas, and a program of long-term ecological description, should be started before the reactor becomes operational. (auth)

**31997** (TID-13097) **THE EFFECTS OF IONIZING RADIATIONS ON THE DEVELOPING ANIMAL WITH SPECIAL REFERENCE TO THE NERVOUS SYSTEM.** Samuel P. Hicks (New England Deaconess Hospital, Boston and Harvard Univ., Boston. Medical School). June 1961. Contract AT(30-1)-1454. 44p.

The effects of ionizing radiations on the development, particularly the nervous system, of mammals are being studied. Investigations were continued on the results of irradiation of the developing cerebral cortex, retina, cerebellum, and thalamus. The nature of cells of the developing nervous system radiosensitive to 200 r was compared with those sensitive to other doses. Tritiated thymidine was used to label cells that were going to divide in order to follow their migrations during subsequent development. The morphogenesis of the abnormalities that characterize the genetic mutant mouse, paralytic, was investigated. The behavior, specifically discrimination of visual patterns as measured by operant conditioning methods, of rats with several cortex abnormalities which can be produced by radiation was studied. The methods by which specific agents, gold thioglucose and gold thiomalate, damage the brain were determined. (M.C.G.)

**31998** (TID-13637) **THE INDUCTION OF GENETIC MUTATIONS BY IRRADIATION IN PLANT SPECIES OF ECONOMIC IMPORTANCE.** Eight Month Progress Report covering the First Six Months. (Università Cattolica del Sacro Cuore di Milano, Piacenza. Istituto di Genetica). [1961]. Contract AT(30-1)-2613, Subcontract No. 64/US. 8p.

Three isolated fields of inbred lines of maize, Minn. A158T, are growing. The A158 line consists of plants developed from seed which received about 8,000 r. Data on the general delay in flowering of tomato plants, following x-irradiation of the seeds, are summarized. The effects of x radiation on tillering of wheat together with the average flowering time in control and treated samples were determined. (M.C.G.)

**31999** (UCLA-482) **SEMIANNUAL PROGRESS REPORT [ON RADIOBIOLOGY] FOR THE PERIOD ENDING JUNE 30, 1961.** (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). Contract AT-04-1-GEN-12. 92p.

Progress is reported in the fields of biochemistry, radiobiology, pharmacology and toxicology, biophysics, nuclear radiology, medicine, and environmental radiation. (M.C.G.)

**32000** (UCRL-9715) **THE FINE STRUCTURE OF NORMAL AND IRRADIATED YEAST CELLS AND YEAST RIBOSOMES** (thesis). James K. Koehler (California.

Univ., Berkeley. Lawrence Radiation Lab.). June 20, 1961. Contract W-7405-eng-48. 80p.

An electron microscope study of the internal organization of the baker's yeast (*Saccharomyces cerevisiae*) is presented with particular emphasis on the structural changes brought about by nitrogen starvation and x irradiation. The general characteristics of normal growing yeast cells fixed with  $\text{KMnO}_4$  were a dense granular cytoplasm devoid of most cytomembranes and mitochondria, and a well defined—usually homogeneous—nucleus located adjacent to the central vacuole. On the other hand, starving cells displayed a progressively less dense cytoplasmic matrix, resulting in enhancement of the visualization of membranous components. The nuclear membrane was apparently a triple structure in growing cells, but had a "classical" double-membrane appearance in starved cells. Intracellular objects believed to be chromosomes are described and their unusual staining properties discussed. A structure thought to correspond to the centriole apparently had an intravacuolar location that may be appropriate to the unusual mode of nuclear division in yeast. Cells irradiated with 100,000 r of x rays underwent only slight changes during the first hours of postirradiation incubation, but after two days underwent drastic alterations suggestive of lysis. Unusual cell forms, referred to as ameboid, also appeared during these late stages of radiation damage. In order to obtain information on the fine structure of yeast at a higher stage of refinement, ribosomes were isolated from growing, starving, and irradiated cells; and subjected to parallel analysis with the ultracentrifuge and electron microscope. Most striking was the discovery of a 65S ribosome present only in rapidly growing yeast cultures and absent from starving or stationary cells. This finding is discussed together with other recent data on the possible role of such a particle in protein synthesis. The sedimentation constants and relative percent abundances of the ribosomes varied in characteristic ways that were substantiated by size measurements made from electron microscope pictures of similar particles. Radiation apparently had little immediate effect on the properties of the ribosomes studied in this work. (auth)

**32001** (AEC-tr-4473) **LONG TERM EFFECTS OF INJURIES CAUSED BY THE ACTION OF IONIZING RADIATION. (EXPERIMENTAL INVESTIGATIONS).** A translation of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii (Eksperimental'nye Issledovaniya)." D. I. Zakutinskii, ed. Translated from a publication of the State Publishers of Medical Literature, Moscow, 1959. 220p.

Twenty-five papers are included. Separate abstracts have been prepared for each paper. (D.E.B.)

**32002** (AEC-tr-4473(p.5-10)) **THE PROBLEM OF THE LONG-TERM EFFECTS OF INJURIES CAUSED BY THE ACTION OF IONIZING RADIATION.** D. I. Zakutinskii. Translated from p.3-10 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

An analysis is made of data on the effects of chronic radiation exposure on animals and their progenies. It is shown that the effects of neutrons are more pronounced than the effects of equal doses of x radiation. A short account is included of the isotopes used by the authors participating in the symposium on The Long Range Effects of Injuries Induced by Ionizing Radiation and on the doses from various isotopes. (R.V.J.)

**32003** (AEC-tr-4473(p.11-15)) LONG-TERM EFFECTS OF THE ACTION OF FAST NEUTRONS ON THE ORGANISM OF ANIMALS. V. V. Sokolov. Translated from p.11-16 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

The effects of fractional 300 to 600 rep doses of fast neutrons in dogs 4 years after exposure and in rabbits after  $1\frac{1}{2}$  years were expressed by disturbances of hematopoiesis and sexual functions and by a progressive lenticular opacity. The results indicated greater long-term damage by fast neutrons as compared to x radiation. (R.V.J.)

**32004** (AEC-tr-4473(p.16-20)) SOME DATA ON THE LONG-TERM EFFECTS OF INJURY TO ANIMALS BY TRITIUM OXIDE. V. F. Zhuravlev. Translated from p.17-21 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

Tritium oxide (0.3 c/kg) introduced orally into rabbits induced light forms of radiation injury. Observations 300 to 330 days after exposure indicated changes in the blood picture characteristic of leukemia, the appearance of myelocytes, and the initial stage of neutrophils. Pathological anatomic and histological studies indicate sarcolemucosis 300 to 330 days following the induced injuries. (R.V.J.)

**32005** (AEC-tr-4473(p.21-8)) ON THE PROBLEM OF THE LONG-TERM EFFECTS OF THE COMBINED INJURY TO ANIMALS OF SILICON DIOXIDE AND RADON. V. S. Kushneva. Translated from p.22-30 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

Three one-hour exposures to  $8 \times 10^{-6}$  c/l concentrations of quartz and radon dust induced weight losses and increased fatality. Chronic silicosis of lungs and severe bronchial damage was observed. Chronic bronchial damage by radon resulted in foreign tissues formation (bone or cancerous). An excess of blood was found in the parenchymatose organs and a dark-brown pigmentation was found in reticular-endothelial cells which was followed by dystrophic and sclerotic complications. (R.V.J.)

**32006** (AEC-tr-4473(p.29-39)) SOME DATA ON THE LONG-TERM EFFECTS OF INJURIES BY SMALL DOSES OF RADIOACTIVE SUBSTANCES IN A CHRONIC EXPERIMENT. D. I. Zakutinskii and L. N. Burykina. Translated from p.31-42 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

Chronic injuries induced by strontium-90 disturb reactions to medicines (caffeine, bromine, adrenalin, acetylcholine, etc.). Chronic strontium injuries effect the reflexes, alter the reactions of cutaneous vessels to adrenalin, and increase the penetrability of blood vessels. The sexual functions were altered before hematopoiesis and are expressed in depressed and disturbed spermatogenesis in males and estrual cycles in females. Morphological changes in the ovaries take place later. The percentage of survival of progenies born  $2\frac{1}{2}$  to 3 years after the initial injuries in the parents was very small. The surviving progenies exhibited difficulties in conditional reflexes, reduced sexual reflexes, depressed blood forming functions and altered reactions to medication. The specific activity of progeny skeletons was about 20 to 50% of the specific activity of the mother's skeleton. During the 24-day nursing period, the strontium activity in the skeletons of progenies doubled. (R.V.J.)

**32007** (AEC-tr-4473(p.40-3)) PATHOLOGICAL CHANGES IN THE ORGANISM OF ANIMALS IN THE CASE OF CHRONIC ACTION BY PRODUCTS OF URANIUM FIS-

SION IN SMALL DOSES. E. N. Klimova. Translated from p.43-7 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

Daily oral introduction of  $10^{-8}$  c/kg concentrations of uranium fission products during 6 months induced considerable chronic disturbances in rats and dogs. The effects were exhibited in reduction of weight, complications during obstetric delivery, early development of bronchial sickness, and reduced resistance to external and internal factors. (R.V.J.)

**32008** (AEC-tr-4473(p.44-51)) CHANGE IN THE PICTURE OF THE BLOOD IN ANIMALS AT LONG-TERM PERIODS AFTER THE INTRODUCTION OF RADIOACTIVE SUBSTANCES INTO THE ORGANISM. I. K. Petrovich. Translated from p.48-56 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

Data are presented on the changes taking place in the blood system of dogs following the introduction of uranium fission products, uranium nitrate,  $\text{Sr}^{90}$ ,  $\text{Sr}^{89}$ , and  $\text{Po}^{210}$ . Dogs treated with  $\text{Sr}^{90}$  after 5 to 18 months exhibit a larger number of erythrocytes and 50% less leucocytes and thrombocytes; dogs treated with 0.005 mc/kg  $\text{Po}^{210}$  perish within 6 to 9 months from anemia which appears about 1 to 3 months before death, while the number of leukocytes remained almost normal and the number of neutrophils increases. Smears of blood taken from animals exposed to various radioactive substances showed an increase of cells with the following structural changes: erythrocyte anisocytosis toward macrocytosis, lymphocyte picnosis, neutrophils, sharply expressed lymphocyte protoplasmic basophilia, appearance of frothing, large lymphocytes in protoplasm, toxic granularity, vacuolization of the protoplasm and cell nuclei, breakage of the nucleus and protoplasm, an increase in the number of plasmocytes, and the appearance of reticular cells in the peripheral blood. (R.V.J.)

**32009** (AEC-tr-4473(p.58-66)) CHANGES IN THE BLOOD AFTER THE SYSTEMATIC PROLONGED ACTION OF X-RAYS IN SMALL DOSES. M. S. Lapteva-Popova. Translated from p.64-73 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

Systematic daily exposure to small doses, 5 to 10 r, of x radiation induces chronic radiation injuries exhibited in alternating periods of progressive sickness and recuperation. The blood picture exhibits four periods: labile blood formation, depressed blood formation, temporary blood formation compensation, and a final period indicated by aplasia, leukemia, and hyperchromic macrocytic anemia. The aplasia was observed only in dogs which perished from the radiation injuries during the first year after total exposure to 900 to 1500 r. Leukemia appeared later ( $2\frac{1}{2}$  to  $4\frac{1}{2}$  years) in dogs exposed to total doses of 4000 to 5500 r. (R.V.J.)

**32010** (AEC-tr-4473(p.67-73)) SOME CLINICAL AND BIOCHEMICAL INDICES OF THE STATE OF THE ORGANISM OF ANIMALS IN LONG-TERM PERIODS AFTER THE INTRODUCTION OF RADIOTHORIUM. S. M. Mikhailovich. Translated from p.74-80 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

Incorporation of a single dose of 0.1 to 1  $\mu\text{c/kg}$  of radiothorium in dogs resulted in fatality. The intravenous injection of radiothorium induced unique pathological processes and biochemical changes that indicate injuries to the liver and kidneys. Reduced cholesterol and its esters



and increased residual nitrogen, especially uric nitrogen, indicate functional disturbances in the liver and kidneys. 2 to 3 years after the incorporation of 0.1  $\mu\text{C}/\text{kg}$  of radiothorium the dogs developed osteosarcomas. (R.V.J.)

**32011** (AEC-tr-4473(p.80-9)) THE CHANGE IN THE RADIOACTIVITY OF AN ORGANISM INJURED BY RADIOACTIVE SUBSTANCES UPON INTRODUCTION OF VARIOUS PHARMACOLOGICAL SUBSTANCES. D. I. Zakutinskii, N. S. Boiko, L. N. Burykina, A. M. Ivanitskii, E. N. Klimova, V. I. Korchemkin, and L. N. Selivanova. Translated from p.88-98 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

The reactions of organisms to medication are either increased or distorted following radiation injury. The sensitivity changes were observed in relation to medications affecting the central autonomic, and peripheral nervous systems as well as cardiac vessels and various enzyme systems. The sensitivity changes spread to various macro- and micro-organisms. (R.V.J.)

**32012** (AEC-tr-4473(p.111-24)) MORPHOLOGICAL CHANGES IN THE LONG-TERM PERIOD OF THE ACTION OF CERTAIN RADIOACTIVE PRODUCTS. A. P. Novikova. Translated from p.122-37 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

Small concentrations of uranium fission products induce disturbances in blood forming organs, the cardiovascular system, and in internal parenchymatous organs. The morphological disturbances are of various chronic characters. The characteristics of disturbances appearing in chronic radiation sickness (pneumonia, mycosis, bronchoectasis, etc.) vary from those of a spontaneous sicknesses to those peculiar to common allergenic reactions. The frequency and localization of induced tumors are determined by the place the fission products are administered and by dosage, the active period, and the type of animal. The morphological effects of uranium are similar to the effects of its fission products, however, the extent of injury is weaker. (R.V.J.)

**32013** (AEC-tr-4473(p.125-31)) CHANGES IN THE GLIA IN THE BRAIN OF DOGS DURING LONG-TERM PERIODS AFTER ACUTE RADIATION SICKNESS. L. L. Vannikov. Translated from p.138-45 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

Chronic disturbances of the central nervous system following acute radiation injuries are discussed. Whole-body exposure to x radiation injures the central nervous system, morphological changes following at a later date. The glial tissue and the connecting vessels are affected first, followed by the neuron apparatus. Alterations in the glial apparatus and vessel walls produce protective reactions against hypoxia in the brain tissue. The alterations change later into pathogenic reactions causing wide-spread, permanent damage in the central nervous system. Prophylactic treatments of dogs before exposure to 600 r of x radiation and post-exposure treatments do not protect the nervous system. The injuries are identical to injuries observed in dogs exposed to 400 to 500 r without preventative or post-exposure treatments. At a later date the injuries of the central nervous system may initiate destructive changes in autonomic functions. (R.V.J.)

**32014** (AEC-tr-4473(p.132-40)) CHANGES IN THE LOOSE CONNECTIVE TISSUE DURING CHRONIC RADIATION SICKNESS. V. V. Shikhodyrov. Translated from p.146-55 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

Data are presented on the changes in areolar tissue at various stages of chronic radiation injuries induced by multiple exposures to fast neutrons in small doses and by injections of radioactive strontium ( $\text{Sr}^{90}$ ) and polonium ( $\text{Po}^{210}$ ). A large number of new cell forms was observed along with continuous fibrosis 29 days after multiple exposures to fast neutrons. Dissolution and resorption of collagenous fibers were followed by the development of new argyrophile fibers. Restoration of the number of fibroblasts, macrophages, and most cells was observed 3 to 5 months after intravenous injections of 0.2 mc/kg  $\text{Sr}^{90}$  into the areolar tissue of dogs. New cell forms prevailed among the fibroblasts. Signs of dystrophic cell and fiber changes appeared after 6 months. Progressive morphological changes in all areolar tissues of dogs were observed 2 to 4 months following intravenous injections of 0.02 mc/kg  $\text{Po}^{210}$ . (R.V.J.)

**32015** (AEC-tr-4473(p.141-6)) MORPHOLOGICAL CHANGES IN ANIMALS DURING LATE PERIODS AFTER THE INTRODUCTION OF SMALL DOSES OF RADIOTHORIUM. E. V. Erleksova. Translated from p.156-62 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

Observations show that single administrations of 0.1  $\mu\text{C}/\text{kg}$  of radiothorium may produce sarcoma due to fixation in bones. (R.V.J.)

**32016** (AEC-tr-4473(p.147-56)) DYNAMICS OF THE DEVELOPMENT OF OSTEOGENIC SARCOMAS IN EXPERIMENTS. R. I. Makarycheva. Translated from p.163-73 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

Long-term bone fixation of radioactive substances results in malignancy. Intraperitoneal injections of 0.4  $\mu\text{C}/\text{kg}$  of  $\text{Sr}^{90}$  in rats resulted in bone sarcomas in 85.4%. Early x-ray examinations showed bone metaphysis either due to uniform consolidation or deossification of the bone structure or due to the appearance of fine focal fixations surrounded by osteoporosis around the edge of the enclosing bone tissue. The appearance of many individual sources of malignancy in different bones or at opposite ends of the same bones is inherent to bone sarcomas induced by the fixation of radioactive substances. (R.V.J.)

**32017** (AEC-tr-4473(p.157-64)) A FURTHER STUDY OF THE APPEARANCE AND DEVELOPMENT OF BONE SARCOMA IN CASES OF INJURY BY RADIOACTIVE STRONTIUM ( $\text{Sr}^{90}$ ) AND BY YTTRIUM ( $\text{Y}^{91}$ ). N. N. Litvinov. Translated from p.174-82 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

Early stages preceding malignancy and later phases of tumor growth were investigated by analyzing the early histopathological changes in animal bones injured by intraperitoneal injection of 0.4  $\mu\text{C}/\text{g}$   $\text{Sr}^{90}$  and 0.6  $\mu\text{C}/\text{g}$   $\text{Y}^{91}$ . The malignancy is caused by progressive disturbances in bone formation induced by radiation. The bone tissue functions are slowly distorted and somehow increased. The process finally results in a tumor. Further development of the malignancy indicated certain regularities. (R.V.J.)

**32018** (AEC-tr-4473(p.165-70)) DEVELOPMENT OF TUMORS IN RABBITS AT THE SITE OF INTRODUCTION OF FISSION PRODUCTS OF URANIUM. L. L. Khamaide. Translated from p.183-9 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

A single intravenous injection of uranium fission products was partially absorbed by rabbit organisms and cre-

ated a strong source of radiation which at a later date induced the development of malignant tumors in the soft tissue. A latent period was observed during the 1 to 2 years the animals were subjected to internal radiations. Optimum concentrations of 0.1 mc/kg of uranium fission products induced tumors. The development of malignant tumors at the injection spot resulted from continuous  $\beta$  radiation. (R.V.J.)

**32019** (AEC-tr-4473(p.171-8)) CHANGES IN THE SEXUAL FUNCTION IN MALE DOGS DURING LONG-TERM PERIODS AFTER INJURY BY FAST NEUTRONS AND X-RAYS. N. E. Trusova. Translated from p.190-9 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

Fast neutrons in 300 to 600 r doses induce permanent sterilization in male dogs. A single 600-r dose of x radiation induced sexual disturbances for 1 to 1½ years. The disturbances were expressed in oligospermia, azoospermia, asthenospermia, and aspermatism as well as shortened erection and ejaculation periods. Partial gonad function was restored 1½ to 2½ years after the exposure to x radiation. Administration of testosterone-propionate and vitamin E speeds the restoration of spermatogenesis. (R.V.J.)

**32020** (AEC-tr-4473(p.179-92)) ON THE PROBLEM OF THE INFLUENCE OF RADIOACTIVE STRONTIUM ON THE SEXUAL FUNCTION AND THE FERTILITY OF WHITE RATS. A. P. Novikova and L. N. Burykina. Translated from p.200-15 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

Blastomatogenic concentrations of strontium-90 effect the gonad function and fertility of white rats resulting in reduced cross breeding and reduced litters. Intoxication often effects the injured animal during pregnancy causing fatality in the final stages. The postnatal period is complicated by inflammation of the parturient canal and sepsis. In contrast to external exposure, the reduced fertility and deviations from normal pregnancy, delivery, and postnatal period are increased with the time of the injection of  $\text{Sr}^{90}$  before conception. Pregnancy and delivery aggravate the course of radiation sickness, however, fatalities among pregnant animals do not exceed fatalities of non-pregnant animals. The average life span of parturient females is longer than that of males. (R.V.J.)

**32021** (AEC-tr-4473(p.193-201)) CLINICAL AND PATHOMORPHOLOGICAL INVESTIGATIONS OF THE OFFSPRING OF DOGS SUBJECTED TO THE ACTION OF FISSION PRODUCTS OF URANIUM. S. P. Voskresenskii and A. P. Novikova. Translated from p.216-26 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

Low-level radioactivity was observed in the bones and organs of progenies born to animals exposed to 1 mc/kg concentrations of uranium fission products introduced orally. The amount of radioactivity is reduced with increased time between exposure and birth. The distribution of radioactivity in the progenies was identical to that in the mother, i.e., the highest activity was found in bones and the least in muscles. The specific radioactivity in bones and organs is reduced after the progenies begin to grow and change to an ordinary diet. Average weights were less than for controls, but no signs were found of disturbances in the growth process; survival up to 5 to 6 months was lower than for controls. Survival among first generation progenies was lowest; fatalities being most common among the newly born and during the first 2 to 3 months. Obesity of certain organs, pre-maturation of thymic corpuscles, and deviations in the multiplication of germinating epithelium

indicate disturbances in lipo- and proteo-metabolism. (R.V.J.)

**32022** (AEC-tr-4473(p.202-9)) PECULIARITIES OF THE PERIPHERAL BLOOD AND HEMATOGENIC ORGANS OF PUPPIES BORN FROM DOGS SUBJECTED TO THE ACTION OF URANIUM FISSION PRODUCTS. T. A. Ivanova. Translated from p.227-34 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

The peripheral blood and hematopoietic organs were studied in progenies of one year old dogs exposed to uranium fission products (with 24%  $\text{Sr}^{90}$ ). The fission products were absorbed from the intestinal tracts and deposited in the bones and in pregnant animals in the organism of the fetuses. A deep and chronic reduction of erythrocytes in peripheral blood was followed by a reduced number of reticulocytes, erythroblasts, and polychromatophores in progenies of dogs injected with 1 mc/kg of fission products. Considerable changes were also observed in the number of leucocytes and leucocytic formula (monocytosis and eosinophyl). (R.V.J.)

**32023** (AEC-tr-4473(p.210-20)) DISTURBANCE OF THE ACTIVITY OF THE STOMACH IN THE OFFSPRING OF DOGS BORN FROM PARENTS INJURED BY RADIOACTIVE SUBSTANCES. N. S. Boiko. Translated from p.235-46 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

Electrophysiological studies were made of the biopotentials during glandular secretion and at rest in progenies born to dogs injured by uranium fission products. The initial activity in the gastric mucous membrane after fasting was 3.2 mv in experimental animals and 7.1 mv in the controls. The frequency of spontaneous oscillations was 5 to 6 times a minute in both groups. During intestinal membrane secretion, excited either by food or humoral agents, the initial mucous membrane potential is reduced. The drop in potential is related to the changes in intestinal secretion. The secretion does not effect the spontaneous oscillations of intestinal potential. Distorted reactions, expressed by an increased potential difference in the secretion function, are related to the intestinal neuro-mucous membrane functions. The digestion and acid secretion functions are identical in both groups of animals. (R.V.J.)

**32024** (JPRS-10131) THE EFFECT OF IONIZING RADIATIONS ON PLANTS. I. M. Vasil'ev (Vasil'yev). Translated from *Agrobiologiya*, No. 2, 259-69 (Mar.-Apr. 1961). 20p. (OTS-61-31605)

A review of basic information is presented on plant radiobiology based on a study of world literature and on investigations carried out at the Academy of Science USSR. (J.R.D.)

**32025** STUDIES ON THE EFFECT OF CARBON DIOXIDE ON X RAY-INDUCED CHROMOSOME ABERRATIONS IN TRADESCANTIA. II. RELATION TO DOSE RATE AND ENVIRONMENT DURING IRRADIATION. Leo E. LaChance (Brookhaven National Lab., Upton, N. Y.). *Am. J. Botany*, 48: No. 6, 489-92 (July 1961). (BNL-5144)

The effect of  $\text{CO}_2$  on radiation-induced chromosome aberrations was investigated to determine the relation of this agent to dose rate and the efficacy of a pretreatment followed by x irradiation in N or *in vacuo*. Carbon dioxide and air, present during the radiation treatment, significantly increase the frequency of chromosome aberrations induced by 300 r of x rays through a 46-fold difference in dose rate. Pretreatment with  $\text{CO}_2$  and air also increased the aberration frequency if the radiation occurred in air.



Pretreatment was completely ineffective when the inflorescences were irradiated in vacuo or in N. Thus it appears that CO<sub>2</sub> acts synergistically with O, in increasing the frequency of chromosome aberrations induced by x rays. (auth)

**32026** PROTOPORPHYRIN AND HEME FORMATION BY ERYTHROCYTES FROM THE X-IRRADIATED AND BLED DUCK. J. Raymond Klein (Brookhaven National Lab., Upton, N. Y.). *Am. J. Physiol.*, 201; 663-7 (Oct. 1961). (BNL-5527)

Frequent bleeding of the adult, male duck was followed by increase in protoheme and free protoporphyrin formation by erythrocytes in vitro. X irradiation of the animal with 800 or 1200 r was followed by decrease in heme formation but not in free porphyrin production. Heme formation was not limited by the natural supply of porphyrin precursors and iron in blood and appears to be controlled by the uptake of iron by the cells. Free porphyrin production does not appear to be regulated by heme formation. (auth)

**32027** EFFECTS OF PRENATAL X-IRRADIATION ON MOTOR PERFORMANCE IN THE RAT. Jack Werboff, Irving Goodman, Joan Havlena, and Melvin R. Sikov (Wayne State Univ., Detroit). *Am. J. Physiol.*, 201; 703-6 (Oct. 1961).

Gravid albino rats of the Sprague-Dawley strain received either 25, 50, or 100 r whole-body x radiation on either day 5, 10, 15, or 20 of gestation. Controls were sham-irradiated. Over 500 surviving offspring were evaluated on measures of motor maturation of the upright and righting responses, motor strength, and locomotor learning during the neonatal period. The results indicate that radiation exposure of 100 r on day 15 of gestation retards motor maturation of the upright and righting responses. Almost all of the radiation groups show a decrease in motor strength as compared to the control group with maximum deficits in the groups receiving 50 or 100 r on day 10 or 15 of gestation. On the locomotor learning measure, the results are not consistent, but the group receiving 100 r on day 15 of gestation is maximally affected. These deficits in motor performance are related to observable motor impairment. It is concluded that low levels of radiation received prenatally can have detrimental effects on the development of motor performances in the rat. (auth)

**32028** PROBLEMS OF RADIOSENSITIVITY IN MIXED CELL POPULATIONS WITH PARTICULAR REFERENCE TO RADIOTHERAPY. R. Oliver and L. G. Lajtha (Churchill Hospital, Oxford). *Brit. J. Radiol.*, 34: 659-66 (Oct. 1961).

In a mixture of, for example, anoxic and aerated organisms or cells, equal sensitization of the two populations leads to no change in relative sensitivity (the ratio of doses for a given depopulation) or in the relative survival for a given survival of aerated cells. There will, however, be an increase in relative survival of the less sensitive (anoxic) cells after a given dose. This latter result may still be true even when the sensitization is greater for the anoxic cells. Protection of the more sensitive (aerated) cells may be the more reliable method of reducing relative survival of the anoxic population. As the number of fractions in which a course of radiation is given is increased the relative survival of the anoxic cells is increased even if the total dose is such as to give the same surviving fraction of aerated cells in each case. The implications of theoretical conclusions from a consideration of dose response curves are discussed in relation to the problems of practical radiotherapy. (auth)

**32029** EFFECT OF GAMMA-RAY UPON FOOD MICROORGANISMS. VI. STUDIES ON THE EFFECT OF GAMMA-RAY UPON E. COLI IN COMPONENTS OF VARIED MEATS. Wataru Watanabe. *Bull. Agr. Chem. Soc. (Japan)*, 24: 673-81 (1960).

A series of studies were carried out on the effects of various conditions on the survival of Escherichia coli gamma irradiated with cobalt-60. The survival of the strain irradiated in the medium containing each of the components of various types of fish-meats and meats is reported. (*Public Health Eng. Abstr.*, 41: No. 9, 1961.)

**32030** EFFECT OF GAMMA-RAY UPON FOOD MICROORGANISMS. VII. STUDIES ON THE EFFECT OF GAMMA-RAY UPON FOOD BACTERIA UNDER SOME CONDITIONS. Wataru Watanabe. *Bull. Agr. Chem. Soc. (Japan)*, 24: 681-4 (1960).

A series of studies were carried out on the effects of gamma rays on a single strain of Escherichia coli irradiated with cobalt-60. The effects of three conditions, which showed the higher survivals of E. coli upon other food bacteria are reported. A pure agar medium was used for irradiation besides a nutrient agar medium. (*Public Health Eng. Abstr.*, 41: No. 9, 1961.)

**32031** IRRADIATION OF CONDENSED MEIOTIC CHROMOSOMES IN LILIIUM LONGIFLORUM. Helen V. Crouse (Columbia Univ., New York and Oak Ridge National Lab., Tenn.). *Chromosoma*, 12: 190-214 (1961). (In English)

X irradiation was used to study the structure of chromosomes and to follow the time of their duplication in Lilium longiflorum. Results of observations on radioinduced 2-side-arm bridges was interpreted as evidence of half-chromatid breakage and exchange. The hypothesis is considered that half-chromatid aberrations involve temporary chemical bonds along the chromosome which are automatically ruptured during the course of an ordinary mitotic interphase. (C.H.)

**32032** RESISTANCE OF CERTAIN STRAINS OF LACTOBACILLUS TO IONIZING RADIATIONS. P. Dupuy and O. Tremeau (Institut National de la Recherche Agronomique, Versailles, France). *Intern. J. Appl. Radiation and Isotopes*, 11: 145-51 (Sept. 1961). (In French)

The resistance to  $\gamma$  rays of 21 strains of Lactobacillus grown in an acid medium was studied. All the inactivation curves which were obtained had a sigmoid aspect. The lethal doses 99% are between 22.8 and 38.2 krad. Thus these bacteria do not appear to have any special resistance to radiation, and their behavior is similar to E. coli. No difference was found between the radiosensitivity of homo- and hetero-fermentative strains. (auth)

**32033** ANTIBODY SYNTHESIS BY TRANSPLANTED HETEROLOGOUS CHIMERA SPLEEN CELLS IN IRRADIATED RECIPIENTS. N. Gengozian, R. Carter, and W. J. Peterson (Oak Ridge National Lab., Tenn.). *J. Immunol.*, 87: 209-17 (Aug. 1961).

Lethally irradiated mice treated with heterologous rat bone marrow (950-r RBM chimeras) were either splenectomized or sacrificed for spleens at various intervals after treatment. Injection of the chimera spleen cells into lethally irradiated recipients resulted in the production of antibody to rat RBC antigen detectable in the serum 7 days after transfer. Under the appropriate experimental conditions this antibody-forming activity was attributable to the chimera spleen, and not the irradiated recipient, which served primarily as an in vivo tissue culture for the cells. In contrast, injection of the chimera spleen cells into midlethally

(800 r) irradiated rats did not result in agglutinin formation to mouse RBC antigen when the serum of the recipients was tested at intervals from 3 to 10 days after transfer. These data support the thesis that in the heterologous chimeras there exists an immunologic reaction of the irradiated host against antigens of the foreign graft, and this *in vivo* antigen-antibody reaction is the underlying mechanism of the secondary disease syndrome observed in these animals. Evidence for graft reactivity against the host was not apparent. (auth)

**32034 THE STATE OF IMMUNITY IN GUINEA-PIGS IMMUNIZED WITH LIVE BRUCELLOSIS VACCINE AND EXPOSED TO RADIATION.** Z. V. Shevtsova (Gamaleya Inst. of Epidemiology and Microbiology, Academy of Medical Sciences, USSR). *J. Microbiol., Epidemiol. Immunobiol. (U.S.S.R.)* (English Translation), 31: 1707-12 (1960).

On immunization with 19-BA live brucellosis vaccine on the 3rd and 10th days after exposure to radiation in a dose of 200 r, guinea pigs died 4 and 2 times more frequently than unvaccinated guinea pigs. If immunization was carried out on the 30th day after irradiation the mortality among irradiated animals showed only a slight increase compared with the mortality among unvaccinated control animals. Immunization carried out before exposure to radiation had no influence upon the mortality of the animals caused by radiation sickness. Guinea pigs immunized after exposure to radiation were insusceptible when infected with the doses of virulent strains of *Brucella* usually employed to challenge immunity (2-4 infective doses). If, however, the animals were infected with a dose twice as high (8 infective doses) the degree of immunity proved to be lower in guinea pigs exposed to radiation, than in guinea pigs immunized and not exposed to radiation. Exposure of guinea pigs to radiation at a time when immunity had already developed had no influence upon the degree of immunity on infection with 4 infective doses of the virulent strain. (auth)

**32035 DECREASED URINARY EXCRETION OF 2-AMINOETHANOL BY IRRADIATED HUMAN BEINGS.** Ralph R. Cavalieri, M. T. Van Metre, and W. I. Sivertsen (U. S. Naval Hospital, Bethesda, Md. and National Naval Medical Center, Bethesda, Md.). *Nature*, 191: 1303-4 (Sept. 23, 1961).

Patients suffering from advanced neoplastic disease, resistant to conventional therapy, were administered whole-body radiation. Complete urine collections were obtained daily from each patient before and after irradiation. Among normal subjects and patients with various forms of cancer, the urinary excretion of aminoethanol, although variable, was never less than 10 mgm a day. Following whole-body radiation, the urinary content of aminoethanol decreased to undetectable concentrations, less than 0.4  $\mu$ gm/ml. In all six patients exposed to single doses in the range of 300 to 900 r, aminoethanol re-appeared in the urine by the twelfth day. (P.C.H.)

**32036 RADIATION DAMAGE TO PROTEINS.** U. S. Kumta and A. L. Tappel (Univ. of California, Davis). *Nature*, 191: 1304-5 (Sept. 23, 1961).

The radiation damage to cytochrome c, hemoglobin, catalase, and egg albumin is defined in terms of radiation lability of amino acids and loss of biological properties of the hemoproteins. The amino acid pattern of scission products and insoluble protein aggregates was also determined. Cystine, methionine, histidine, phenylalanine, tyrosine, threonine, and serine were most susceptible to radiation damage, and aspartic acid, glutamic acid, lysine,

and alanine were the most stable. Rank in terms of radiation lability, however, varied with the protein. Radiation lability of sulfur amino acids in the proteins gave rise to volatile products responsible for some undesirable flavor in irradiated foods. (P.C.H.)

**32037 LOCAL ENERGY DENSITY IN IRRADIATED TISSUES. I. RADIOBIOLOGICAL SIGNIFICANCE.** H. H. Rossi, M. H. Biavati, and W. Gross (Columbia Univ., New York). *Radiation Research*, 15: 431-9 (Oct. 1961).

The definition and measurement of the nonuniformity of energy density on a microscopic scale are discussed as important objectives of radiation dosimetry. The symbol  $Z$  is employed for the energy absorbed per unit mass in spheres within the irradiated material. The probability of finding any value of  $Z$  is denoted by  $P(Z)$ .  $P(Z)$  is a function of  $Z$ , of the absorbed dose, and of sphere diameter. A method for the experimental determination of  $P(Z)$  is outlined, and from preliminary data the general behavior of  $P(Z)$  is discussed. A hypothetical example is employed to develop some of the possible applications for the  $Z$  concept. Regardless of the validity of the assumptions made, it is believed that the  $Z$  concept may be useful in radiation research. (auth)

**32038 ACTIVE SITE OF DEOXYRIBONUCLEASE I. [PART] I. THE NATURE OF ACTIVE SITE OF DEOXYRIBONUCLEASE I.** S. Okada and G. L. Fletcher (Univ. of Rochester, N. Y.). *Radiation Research*, 15: 452-9 (Oct. 1961).

Ionizing radiation and specific inhibitors for amino acid residues were used to demonstrate which amino acid residues are involved in the active site of the enzyme deoxyribonuclease I. Bromoacetic acid, iodoacetic acid, diisopropyl-fluorophosphate, p-chloromercuribenzoate, tryptophan, histidine, cinnamic alcohol, cinnamaldehyde, indole, arginine, and morpholine did not inhibit the enzyme. On the other hand, N-bromosuccinimide inhibited the enzyme strongly. The relationship between the tryptophan content and the enzyme activity treated with N-bromosuccinimide suggests that, at most, two tryptophan residues are likely to be involved in the active site of the enzyme. The radio-induced degradation reaction of tryptophan residues of the enzyme consisted of a fast and a slow reaction. Since the slope of the fast reaction was similar to that of the inactivation of the enzyme, it seems likely that, at most, two tryptophan residues of the fast reaction are involved in the active site. The tryptophan residues of the fast reaction are probably those residues exposed to the outside of the protein molecule, and the residues of the slow reaction are those hidden inside the molecule. The G value of the fast reaction was 0.40, and that of the slow reaction was 0.08. A quantitative evaluation of G values of inactivation of the enzyme (0.20) and of degradation of tryptophan residues of the fast group indicated that the one specific tryptophan residue appears to be involved in the active site of deoxyribonuclease I. (auth)

**32039 EARLY AND LATE HISTOLOGICAL CHANGES FROM BETA-IRRADIATION BY  $Sr^{90}$  BEADS IMPLANTED WITHIN THE RAT FEMUR.** L. E. Detrick, H. C. Upham, C. P. Miles, A. K. Dunlap, and T. J. Haley (Univ. of California, Los Angeles). *Radiation Research*, 15: 467-74 (Oct. 1961). (UCLA-470)

The  $\beta$  irradiation from  $Sr^{90}$  beads implanted within the marrow cavity of the rat femur, 5 mm from the epiphyseal plate, produced progressive destruction of the shaft bone and bone marrow. The trabecular tissue of the metaphysis was not damaged. Damage to the epiphyseal plate was ob-



served only in 3 animals in which the bead had deteriorated. Bone tumors and bone marrow changes indicative of leukemia were not observed even after 180 days of irradiation with doses as high as 445 krep. The relationships between total dose of irradiation, distance from the source, and total time of irradiation were discussed in regard to other bead implantation studies. It appears that beads with a lower  $\text{Sr}^{90}$  content, which would not produce fractures, might produce malignancies if the time interval of irradiation was greater than 180 days. (auth)

**32040** HISTOPATHOLOGIC EFFECT OF HIGH-ENERGY-PARTICLE MICROBEAMS ON THE VISUAL CORTEX OF THE MOUSE BRAIN. W. Zeman, H. J. Curtis, and C. P. Baker (Brookhaven National Lab., Upton, N. Y. and Indiana Univ., Indianapolis). *Radiation Research*, 15: 496-514 (Oct. 1961).

A histopathologic study was made of the radiogenic lesions produced in the mouse visual cortex with high-energy-particle beams 1 mm, 0.250 mm, 0.075 mm, and 0.025 mm in diameter. Irradiation with the smallest microbeams results in a complete and definite destruction of nerve cell bodies only. Irradiated nerve fibers are not destroyed; neither is there permanent damage to vessels. Interstitial glia cells are partly preserved. The dosages necessary to produce such a lesion in 24 days are extremely high, 400,000 rads for a 0.025-mm beam. The threshold dose is very constant. This is in contrast to lesions produced by larger beams. Here, either total tissue necrosis results from the irradiation, or destruction of nerve cell bodies is very scant and patchy in distribution. Acute circulatory disturbances and delayed radiation damage of vessels are constant findings. The dosage required to produce a complete destruction of nerve cells within 24 days is 14000 rads for 1-mm beams, but this dose also renders the other tissue components necrotic. This threshold dose has a wide range from 9300 rads to 26000 rads. From the observations it is apparent that, the larger the irradiated tissue volume, the greater are the fluctuations in tissue radiosensitivity; and that tissue radiosensitivity is inversely related to the tissue volume being irradiated. Radiosensitivity of mouse brain cortex to 1-mm beams seems to be largely determined by the radiosensitivity of the vascular apparatus; direct nerve cell necrosis by radiation appears to be of secondary importance but it is demonstrable. With microbeam irradiation the radiosensitivity seems to be determined exclusively by the radiosensitivity of the nerve cells themselves. (auth)

**32041** SOME EFFECTS OF X-IRRADIATION ON LONGEVITY IN HABROBRACON FEMALES. Arnold M. Clark (Univ. of Delaware, Newark and Oak Ridge National Lab., Tenn.). *Radiation Research*, 15: 515-19 (Oct. 1961).

Habrobracon females, when exposed to x rays as larvae, pupae, or adults, show a decrease in adult life span which is shortened in proportion to the amount of radiation delivered. Radiation damage to larvae and pupae, which cannot be detected simply by observing the incidence of adults that emerge, is revealed when adult life span is measured. Groups irradiated as adults at the doses delivered show no immediate mortality. The time of onset of death within the group depends on the amount of radiation delivered. Death is delayed for a longer time for smaller doses. Although adults will survive a dose of 200,000 r, as little as 5000 r causes a reduction in life span. (auth)

**32042** THIAMINE TRANSPORT ACROSS THE IRRADIATED ISOLATED RAT INTESTINE. L. E. Detrick, H. C. Upham, A. K. Dunlap, and T. J. Haley (Univ. of California,

Los Angeles). *Radiation Research*, 15: 520-6 (Oct. 1961). (UCLA-471)

The intestine of rats subjected to 525 r of acute whole-body x irradiation showed decreased thiamine absorption when isolated and tested on the third post-irradiation day. Intestinal absorption of thiamine did not reach the control values even after 17 days. This defect in absorption appeared to be related to the increased vacuolization and nuclear swelling in the epithelial cells. The reasons for decreased absorption of thiamine are discussed, and it is suggested that it is related to subcellular damage in the crypt cells. (auth)

**32043** MODIFICATION OF RADIATION-INDUCED GASTROINTESTINAL EFFECTS BY BARIUM MEALS. Robert A. Conard and William A. Scott (Brookhaven National Lab., Upton, N. Y.). *Radiation Research*, 15: 527-31 (Oct. 1961). (BNL-5263)

Some protection from injury to the gastrointestinal tract of rats was afforded by giving 5-ml barium meals at 4 and 2 hours prior to x irradiation. Such protection was evidenced by reduction of 4-day and 7-day mortality, with increased survival time, lower incidence and less severity of diarrhea, and a tendency to less weight loss in the treated animals compared to untreated irradiated controls. This beneficial effect was noted with doses of 950, 1000, 1100, 1175, and 1250 r but was not noted in the group receiving 850 r. Possible use of such a technique in clinical radiation therapy involving the abdomen is discussed. (auth)

**32044** CONTRIBUTION TO THE MORPHOLOGY OF X- AND RADIUM-IRRADIATED MOUSE OVARIES. I. THE OVUM. Erhard Jostes and Eberhard Scherer (Universität, Marburg, Ger. and Städtische Krankenanstalten, Essen). *Strahlentherapie*, 115: 337-65 (July 1961). (In German)

Histological and cytological examinations on the ovaries of the white mouse showed, by the use of electron microscopy, that after a monophasic whole-body radiation of animals with 100 r and 400 r considerable permanent damages arise very early. The findings reported in this communication refer only to the egg cell, other cell elements are reported in later communications. With a continuous radiation trial with only 1.2 r per day clear nuclear changes showed themselves after 7 weeks (=59 r), severe nuclear changes after 9 weeks (=76 r), which correspond with the findings 3 hours after the use of 400 r. (auth)

**32045** BIOLOGICAL EFFECTIVENESS OF 30-MEV ELECTRONS IN DEPENDENCE ON THE TISSUE DEPTH AND IN COMPARISON WITH 180-KEV AND 31-MEV PHOTONS. I. LETHALITY TEST ON ONE-HOUR DROSOPHILA EMBRYOS. Hedi Fritz-Niggli and Hans R. Schinz (Kantonsspitals, Zurich). *Strahlentherapie*, 115: 379-93 (July 1961). (In German)

Equal ionization doses ( $\rho$ -measurement values) of 30 Mev electrons act the same, both qualitatively and quantitatively on 1 h  $\pm$  10 min embryos of drosophila melanogaster at different depths in the plexiglass phantom (0, 1.25, 5.25, 8.25, 10.25, and 12.25 cm). The dose effect curves (dose in rad noted) of 180 kev photons, 31 Mev photons, and 30 Mev electrons coincide. The relative biological effectiveness (RBE) is therefore 1, and the number in rad is the same as the number in rem. If the measurement values are  $\rho$  noted in the action curves of 180 kev photons, 31 Mev photons, and 30 Mev electrons draw apart somewhat. The chosen values of the factor k, with which  $\rho$  is converted into rads, possess therefore probably a realistic value. 1-hour drosophila embryos register neither a difference in the linear ionization density nor the difference in the continuous application (180 kev photons) and the discontinuous megavolt

radiation, which per second delivers 50 electron flashes in a period of 10 microseconds. This independency of the ray effects in the 1-hour drosophila to the ionization density explains the concordance of the biological and physical transition curves of 30 Mev electrons. (auth)

**32046** EXPERIMENTS ON THE EFFECT OF THE ENERGY SPECTRUM OF FAST ELECTRONS ON BIOLOGICAL REACTIONS. Benno Markus and Elisabeth Sticinsky (Universitäts-Hautklinik, Göttingen, Ger.). *Strahlentherapie*, 115: 394-403 (July 1961). (In German)

After a survey of the present knowledge about the LET (linear energy transfer) spectrum of fast electrons and of the possibilities for the examination of its influence on biological reactions experimentally, radiation tests with eggs of drosophila with 14.2-Mev electrons are described. The eggs were irradiated in a plexiglass phantom at depths of 100, 30, and 20% of the relative depth dose under specially controlled conditions with the same ionization dose of 200 r (verging on LD<sub>50</sub>) with 65 r/min. As opposed to the 100% depth, the damage rate at the 30 and 20% depths was 19 to 22% higher. A discussion of the methodic influences, especially of dosimetry, shows a true effect. (auth)

**32047** ANIMAL EXPERIMENTAL, HISTOLOGICAL, AND DOSIMETRIC INVESTIGATIONS ON SIMPLE RADIO-BIOLOGICAL MODELS AND THEIR PRACTICAL APPLICATION. II. RADIATION EPILATION IN ALBINO GUINEA PIGS. Ludwig Rausch, Gerhard Breittling, and Emil Unger (Universität, Marburg, Ger. and Universität, Tübingen, Ger.). *Strahlentherapie*, 115: 411-26 (July 1961). (In German)

With reference to the previous communication, which contained preliminary general remarks, valid also for the present work and the discussion of the first model, a report is given on a second model used in experimental work with animals in regard to sieve and grid irradiation, i.e. the epilation of albino guinea pigs by soft x rays. The article discusses literature, experimental technique, macroscopic course, the underlying histopathological changes, exact data on the dose distribution, and finally suitable experimental arrangements, form of evaluation, and applicability of the model for various radiobiological purposes. (auth)

**32048** LATE ALTERATIONS IN RADIUM-IRRADIATED COLLUM CARCINOMA IN ELECTRON MICROSCOPIC PICTURES. Hermann Themann and August Verhagen (Städtische Frauenklinik, Essen and Universität, Münster, Ger.). *Strahlentherapie*, 115: 427-40 (July 1961). (In German)

Under exact knowledge of the total delivered dose and the dose capacity, the radium radiated human collum carcinoma was examined for their changes in the sublight microscopic sphere. As opposed to untreated carcinoma, great morphologic differences were found. The prevailing changes consisted of a dissociation of the single carcinoma groups and single cells, of the vacuolization of the protoplasm and of the mitochondria, in the appearance of closely described "enclosed bodies," and an advanced necrobiosis. On the cell nucleus morphologically perceptible radiation reactions could not be observed. By the side of markedly changed cells, cells without morphologically recognizable damage were found. The question of the dependency of the radiation sensitivity or radiation resistance of certain cell organella as well as the more usual damage of the single cell organella, are discussed. (auth)

**32049** ELECTROENCEPHALOGRAPHIC CHANGES AFTER X-RAY EPILATION OF THE HAIR ON THE HEADS

OF CHILDREN. Willi Born and Heinrich Hubach (Universität, Freiburg i. B.). *Strahlentherapie*, 115: 465-77 (July 1961). (In German)

Electroencephalographic control examinations on children, who on account of microsporion (microsporion tinea capitis) have been epilated with x rays under adequate, or extremely careful conditions, locally or totally, once or fractionated, showed after fractions of the epilation dose as well as after monophasic radiation of single small fields, characteristic deviations from the normal curve as a sign of temporary, but, nevertheless, several weeks long, provable functional cerebral disturbances. These are the expression of a special radiation sensitivity of the young brain, however, so trifling, that no coarse morphological changes or no possible cerebral damage can be deducted from them. The indication to the appropriate x-ray epilation in suitable cases remains through our findings unchanged. (auth)

**32050** GENETIC CONTROL AND RADIATION EFFECTS IN NICOTIANA TUMORS. Harold H. Smith and Harlan Q. Stevenson (Brookhaven National Lab., Upton, N. Y.). *Vererbungslehre*, 92: 100-18 (1961). (BNL-5237) (In English)

Tumors are formed in hybrids and amphidiploids combining the species *Nicotiana langsdorffii* with *N. glauca* or *N. suaveolens*. Addition of an *N. sanderae* genome to these combinations suppresses aerial tumor formation. When the  $F_1$ , *N. Langsdorffii* × *N. sanderae*, is crossed with *N. suaveolens*, *N. glauca* or amphidiploids involving these species, segregation and recombination gives plants with wide differences in tumor expression. Additional evidence of genetic control is afforded by correlations, probably representing linkages, between presence of tumors and marker genes from *N. langsdorffii*, lack of tumors and marker genes from *N. sanderae*. A nontumorous mutant of *N. glauca-langsdorffii*, induced by x-raying seeds, gives  $F_1$  hybrids with no tumors when crossed with the tumor forming amphidiploid. A number of different genotypes involving the species *N. glauca* and *N. suaveolens* combined with genomes or gene recombinations of *N. langsdorffii* and *N. sanderae* were grown for approximately 108 days under  $\gamma$  radiation of from 5 to 450 r per 20-hour day. Certain genotypes, including the radiation induced mutant, produced no tumors in unirradiated controls or at any level of irradiation including the highest dosages. Others produced tumors at all dosages as well as in the controls. A third group formed tumors late in the season only under  $\gamma$  irradiation, beginning at levels of 200 to 350 r per 20-hour day depending on the genotype. Aging accentuated tumor formation in some genotypes, but not in others. In general terms, tumor formation is viewed as initiated through an abnormal nucleic acid condition, dependent on maldistribution or an accumulative unbalance of nucleic-acid directed metabolic products, and resulting in abnormal production of growth regulatory substances maintained at levels for tumorous growth through the continuing action of the basic nucleic acid aberrancy. (auth)

## Radiation Sickness

**32051** (ANL-6368(p.12-15)) THE COMPARATIVE EFFECTIVENESS OF AET AS A PROTECTIVE AGENT AGAINST MORTALITY IN NEUTRON- AND  $\gamma$ -IRRADIATED MICE. D. L. Jordan, H. H. Vogel, Jr., N. A. Frigerio, N. Bink, and R. Barhorst (Argonne National Lab., Ill.).

Results are summarized from studies on the effect of pretreatment of female mice with S,2-aminoethylisothi-



uronium bromide hydrobromide (AET) on acute mortality after exposure to fission neutrons and  $\text{Co}^{60}$   $\gamma$  radiation. Data are tabulated. Pretreatment with AET did not significantly change the mean survival time of those mice dying in the acute 30-day period after either  $\gamma$  or neutron irradiation. The withholding of food before oral administration of AET did not increase the radioprotective action of this agent. (C.H.)

**32052** (ANL-6368(p.64-70)) ON THE KINETICS OF MECHANISMS BY WHICH ACUTE RADIATION INJURY ACCUMULATES. S. A. Tyler and S. P. Stearner (Argonne National Lab., Ill.).

A model of radiation injury accumulation is presented and the kinetics by which acute radiation injuries accumulate are discussed. The possibilities of analytical approaches in attempts to distinguish mortality resulting from each of several radiation injuries are considered. It is pointed out that selection of the quantity by which reduction in dose effectiveness is measured is extremely important in such studies. Data are included on the 10 to 90% range of radiation mortality for 3 periods that span the first 30 days after irradiation of chickens and the percent of radiation mortality within the second period of chicks entering this period alive when compared with data on dose and exposure time. (C.H.)

**32053** (ANL-6368(p.78-81)) THE  $\text{LD}_{100/35}$  FOR  $\text{Sr}^{90}$  IN THE EVERGLADES RAT SNAKE (ELAPHE OBSOLETA ROSSALENI). L. S. Lombard, C. F. Decker, and A. M. Brues (Argonne National Lab., Ill.).

Progress is reported in studies on neoplastic changes induced by  $\text{Sr}^{90}$  in the skeleton of the snake. Six snakes were injected intracardially with  $\text{Sr}^{90}$  at the rate of  $1 \mu\text{g/g}$  body weight. Clinical signs included anorexia, weight loss, subcutaneous edema, and bleeding from the mouth. All died within 35 days. At necropsy, the spleens were small and hemorrhages were observed in the visceral organs and subcutaneous and intramuscular tissues. (C.H.)

**32054** (AEC-tr-4473(p.52-7)) ON THE DISTURBANCE OF HEMATOGENESIS IN THE LONG-TERM PERIOD OF CHRONIC RADIATION SICKNESS PRODUCED BY POLONIUM, RADIOTHORIUM AND RADON. A. A. Kanarevskaya and S. Yu. (Ye.) Posherstnik. Translated from p.57-63 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

Disturbances induced by injections of polonium, radiothorium, and radon were expressed in periodic depressions of erythro- and leucopoiesis followed by partial restoration of the blood forming function. Chronic injuries result in acute anemia with disturbances in leucopoiesis and thrombopoiesis. Compensatory blood forming in the tubular bone occurs simultaneously with the injuries. Disturbances in marrow formation appear first in the chest, then in the spine, ribs, and other bones. (R.V.J.)

**32055** (AEC-tr-4473(p.74-9)) CHARACTERISTICS OF THE REACTIVITY OF ANIMALS SUFFERING FROM RADIATION SICKNESS DEVELOPED WITH EXPERIMENTAL NEUROSIS. E. N. Antipenko. Translated from p.81-7 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

The neurotic state of animals 8 to 36 months after acute radiation sickness is expressed by leukopenia and increased penetrability of the vessels, reduced arterial pressure, and damage to the intestinal barriers. Studies of changes in neurosis showed a certain definite regularity in the restoration of radiation induced damage. After 8 months the blood coagulating system and thrombocyte count were

restored; after 18 months the vessel penetrability was restored; and after 36 months the arterial pressure and erythropoiesis were restored. Granulo- and lymphopoiesis were not restored even after 3 years. (R.V.J.)

**32056** (AEC-tr-4473(p.90-110)) THE INFLUENCE OF LOSS OF BLOOD ON ANIMALS SUFFERING FROM ACUTE RADIATION SICKNESS. V. N. Pravetskii. Translated from p.99-121 of "Otdalennye Posledstviya Porazhenii Vyzvannykh Vozdeistviem Ioniziruyushchei Radiatsii."

The effects of blood-letting in animals suffering from radiation injuries were studied in order to determine the mechanisms of blood compensation, the degree of disturbances and the restoration period. Blood-letting initiated in dogs following  $1\frac{1}{2}$  to 3 and 6 months after radiation injury showed a less pronounced leucocytosis and earlier normalization than control dogs. Some animals exhibited a sharply reduced number of leucocytes down to a leucopenic level the restorative mechanism compensating for the loss of blood appeared 6 months following the exposure. (R.V.J.)

**32057** EVALUATION OF CYREN-B AS A LEUKOCYTE PROTECTING AGENT IN PATIENTS UNDERGOING RADIOTHERAPY OR CHEMOTHERAPY FOR MALIGNANT LYMPHOMA. John H. Webster, Ellen M. Lessmann, and Joseph E. Sokal (Roswell Park Memorial Inst., Buffalo). *Acta Radiol.*, 56: 231-6(Sept. 1961). (In English)

The alleged protective effect of diethyldioxystilbenedipropionate (Cyren-B) against radiation or nitrogen mustard induced leukopenia was investigated in 67 patients with malignant lymphoma. The patients were randomly allocated to treatment and control groups, and appropriate statistical techniques were used to determine whether this drug afforded any significant protection. No protective action of the drug against leukopenia or thrombocytopenia was seen. The authors were unable to predict the likelihood of developing thrombocytopenia or leukopenia in the individual patient about to undergo treatment. (auth)

**32058** CARDIOVASCULAR EFFECTS OF RADIOPROTECTIVE COMPOUND BETA-AMINOETHYLISOTHIURONIUM  $\text{Br}-\text{HBr}$  (AET). David H. Knott and R. R. Overman (Univ. of Tennessee, Memphis). *Am. J. Physiol.*, 201: 677-81(Oct. 1961).

The radioprotective compound beta-aminoethylisothiuronium  $\text{Br}-\text{HBr}$  (AET) produces marked cardiovascular changes in various mammals. The problem was investigated in the dog by the slow intravenous infusion and the rapid intravenous injection of AET. Blood pressure, electrocardiogram, and cardiac output were measured, and peripheral resistance, plasma and blood volumes, stroke volume, and modal circulation time were subsequently determined. A dominant response noted in this study was a marked hypertension induced by the slow infusion and rapid injection of AET. This alteration was due to an increased peripheral resistance. In addition, a rapidly developing hypotension following a hypertensive peak was observed in animals which were rapidly injected with AET. It was also noted that the myocardium was refractory to vagal stimulation after AET administration. The action of this compound appears to be a direct one on the peripheral vasculature and the myocardium. (auth)

**32059** POTENTIAL ANTIRADIATION DRUGS. II.  $\beta$ -AMINOMERCAPTANS DERIVED FROM D-ALLOSE. Leon Goodman and James E. Christensen (Stanford Research Inst., Menlo Park, Calif.). *J. Am. Chem. Soc.*, 83: 3823-7 (Sept. 20, 1961).

A complex neighboring group approach provided a suc-

successful synthesis of methyl 3-amino-2,3-dideoxy-2-mercapto- $\alpha$ -D-allopyranoside hydrochloride (IX). The blocked 3-aminoaltrose (II) afforded, in two steps, the crystalline dithiocarbamoyl mesylate (VI) which, heated in pyridine, cyclized to the thiazoline V, that was reduced to the thiazolidine IV. Compound IV was deblocked and hydrolyzed, via the crystalline mercuric salt VIII, to the aminomercapto glycoside IX. (auth)

**32060 POTENTIAL ANTIRADIATION DRUGS. III.  $\beta$ -AMINOMERCAPTANS DERIVED FROM D-ALTROSE.**

James E. Christensen and Leon Goodman (Stanford Research Inst., Menlo Park, Calif.). *J. Am. Chem. Soc.*, 83: 3827-34 (Sept. 20, 1961).

Two methods were explored for the preparation of a glycoside of 3-amino-2,3-dideoxy-2-mercapto-D-altrose. In the first, unsuccessful approach, a synthesis for the unique sugar episulfide VI was developed. Ammonolysis of VI, however, afforded polymeric products containing amino and mercaptan groups. The successful approach employed a trans-benzylthiosylate (XVII) which was converted to a trans-benzylthioazide (XIX). A change of blocking groups gave the trans-benzylthioazide XXIII, which, treated with sodium and liquid ammonia and the product XXII deblocked with methanolic hydrogen chloride, afforded the desired aminomercapto glycoside (XXI,  $R = CH_3$ ). (auth)

**32061 CLINICAL COURSE OF CASE K. C. C. Lushbaugh (Los Alamos Scientific Lab., N. Mex.). *J. Occupational Med.*, 3: No. 3, Special Suppl., 150-4 (Mar. 1961).**

The clinical course is reviewed of a patient subjected to an occupational exposure of average whole-body radiation of approximately 4,500 rads of mixed neutrons and  $\gamma$  radiation. The first 20 min after exposure was characterized by immediate physical collapse and mental incapacitation, which progressed to semiconsciousness and severe prostration. Such severe cardiovascular shock was evident that death seemed imminent and he seemed to suffer severe abdominal pain. Enough subjective improvement occurred during a period of about 28 hrs to encourage continued attempts to alleviate his anoxia, hypertension, and circulatory failure. The unheralded onset of rapidly increasing irritability and uncooperativeness, bordering on mania, was followed by coma and death approximately 35 hrs following radiation exposure. (C.H.)

**32062 GROSS AND MICROSCOPIC PATHOLOGY AND NEUROPATHOLOGY. C. C. Lushbaugh (Los Alamos Scientific Lab., N. Mex.). *J. Occupational Med.*, 3: No. 3, Special Suppl., 160-8 (Mar. 1961).**

The gross and microscopic pathological findings are described for a patient who died following occupational exposure to whole-body radiation of approximately 4,500 rads mixed  $\gamma$  and neutrons. The microscopic evidence indicated circulatory disturbance of the brain, manifested by generalized cerebral swelling, perivascular transudates, and hemorrhages. The brain swelling and edema could be explained by the right cardiac failure and resulting cerebral passive congestion and anoxia. (C.H.)

**32063 SPECIAL STUDIES. Wright H. Langham (Los Alamos Scientific Lab., N. Mex.). *J. Occupational Med.*, 3: No. 3, Special Suppl., 169-77 (Mar. 1961).**

Results are reported from special biochemical studies, whole-body counts, and  $\gamma$ -spectral measurements performed to collect information on the effects of whole-body exposure to an average dose of 4,500 rads mixed  $\gamma$  and neutron irradiation. The data were also used for dose calculations and for comparison with similar data from past cases of serious exposure. Samples of urine, feces, blood, and tissues were analyzed for induced  $Na^{24}$  activity, specific activity of  $P^{32}$ , neutron-induced  $P^{32}$  in sulfur-rich tissues, and Pu in tissues. The victim of a fatal radiation exposure had spent a total of approximately 6 yr as a Pu process operator and had a potential exposure to this material. Data on Pu in tissues and organs are compared with records of Pu levels in work areas during the employment period. (C.H.)

**32064 DOSIMETRIC CALCULATIONS. Payne S. Harris (Los Alamos Scientific Lab., N. Mex.). *J. Occupational Med.*, 3: No. 3, Special Suppl., 178-83 (Mar. 1961).**

Problems are discussed which were involved in dosimetric calculations on three individuals exposed to mixed  $\gamma$  and neutron irradiation from an accidental critical excursion in a Pu processing plant. Complications connected with evaluation of doses to personnel involved in the accident ranged from the geometric and moderator characteristics of the source to the movement of personnel in the vicinity of the source after the accident. The standard dosimeter coverage was inadequate or absent. The critical reaction occurred in a 225-gal stainless steel tank containing approximately 130 gal of material. The critical reaction occurred in the upper layer of solution, in which 3.27 kg of Pu was dissolved. Apparently, when a stirrer was started, the material was brought into a critical configuration in the horizontal center of the tank. The geometric level of the critical reaction was determined by linear measurement of the long-lived induced  $\gamma$  activity in a stainless steel baffle located inside the tank. The whole event consisted of a single supercritical reaction. The total fissions that occurred were determined subsequently by standard radiochemical analysis and found to be approximately  $1.5 \times 10^{17}$ . Calculations of neutron dose were based on the assumption that total neutron exposure was due almost exclusively to fast neutrons. Measurements were made of blood and total-body  $Na^{24}$  activity, serum Na specific activity, induced activity in materials in pockets and clothing. Results were compared with results from an experiment using a Los Alamos prompt critical assembly and data from burros exposed to fast neutron irradiation. Estimations of  $\gamma$ -ray dose were based on purely theoretical considerations and on readings from previously unexposed film badges located 137 ft from the center of the criticality excursion. Estimates of various factors contributing to whole-body dose are tabulated. (C.H.)



# CHEMISTRY

## General and Miscellaneous

**32065** (ANL-6368 (p.84-92)) PREPARATION AND PROPERTIES OF S-ADENOSYL-L-HOMOCYSTEINE, S-ADENOSYL-L-HOMOCYSTEINE SULFOXIDE, AND S-RIBOSYL-L-HOMOCYSTEINE. John Duerre (Argonne National Lab., Ill.).

A simple procedure for the preparation of crystalline S-adenosyl-L-homocysteine is reported. The product is free from all impurities detectable by conventional methods. S-Adenosyl-L-homocysteine was found to be quite resistant to alkaline treatment; however, it undergoes cleavage in the presence of weak acid, producing adenine and a new compound, S-ribosyl-L-homocysteine. The latter is split with stronger acid to ribose and homocysteine. The sulfoxide of S-adenosyl-L-homocysteine has been prepared. As expected, it is more labile to alkaline treatment than S-adenosyl-L-homocysteine, and the fragments formed are adenine, S-ribosyl-L-homocysteine sulfoxide, homocysteine, and ribose. (auth)

**32066** (BMI-1534 (Del.)) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING JULY 1961. Russell W. Dayton and Clyde R. Tipton, Jr. (Battelle Memorial Inst., Columbus, Ohio). Aug. 1, 1961. Contract W-7405-Eng-92. 92p.

Progress is reported for various reactor fuel projects. Observations on the behavior of  $U_3O_8$ -CaO,  $U_3O_8$ -CdO, and  $U_3O_8$ - $Al_2O_3$  mixtures held at 1200°C and  $6 \times 10^4$  atm for 24 hr are reported. The sliding friction of type 304 stainless steel surfaces at 80 to 1200°F decreased when sodium was introduced between the surfaces. X-ray diffraction studies of the phases existing in cast Nb-40.2 wt % Pu-1.2 wt % Si and Nb-23.7 wt % Pu-2.8 wt % Si alloys are reported. U-10 wt % Nb base alloys were found to increase their hardness with increasing Pu content. Development of tubular fuel element fabrication by explosive forming and expansion of seam-welded flat plates is described. Fractional areas of contact of Ni-Cu couples vacuum hot-pressed at 1000°F and pressures of 2000 and 4000 psi are reported. Skull arc-melting techniques were developed for the melting and casting of uranium carbide. The physical properties of uranium carbide compacts irradiated to 0.7 at. % burnup are described. Limitations of  $Al_2O_3$  coatings on fuel particles are discussed. The densities of pyrolytic carbon coatings on fuel powders were determined. Postirradiation studies were made on coated fuel particles in graphite spheres. Evidence was found for migration or recrystallization in NaCl crystals and for decoration of dislocations by precipitated Ag in AgCl crystals exposed to fission recoils. Studies were made on the reactions of UC with pyrolytic carbon coatings and of  $UO_2$  with  $Al_2O_3$  coatings. Results of studies of BeO coating deposition on  $UO_2$  shot are given. Development of oxide-coated  $UO_2$  particles was continued. Corrosion studies were made in the Fluoride Volatility process on INOR-8, Hastelloy X, and W-5 wt % Cu-5 wt % Ni alloy with  $ZrO_2$  additions and a HF sparge at 700°C, and on HyMu-80 in LiF-NaF- $ZrF_4$  melt sparged with  $F_2$  at 500°C. Work on joining of type 410 stainless steel to Zircaloy-2 is described. Studies of irradiation effects on Hastelloy X-clad  $UO_2$  and  $UO_2$ -BeO specimens were carried out. Corrosion resistance of soldered Th-Th, Th-U, and U-U joints plated with Ni was evaluated by exposure to 100% humid air and subsequent bend tests. (D.L.C.)

**32067** (GA-2144 (Rev.)) THE TRANSPIRATION METHOD. Ulrich Merten and Wayne E. Bell (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Sept. 29, 1961. Contract AT(04-3)-164. 35p.

A review is presented of diffusion and kinetic aspects of the transpiration method for studying heterogeneous equilibria involving gases in which a discussion of their limiting effects, particularly in high-temperature chemistry, is given. Various aspects of experimental techniques are examined that may be helpful to investigators. Techniques are also described by which this method may be used to establish molecular formulas of vapor species. (J.R.D.)

**32068** (MLM-1116) MOUND LABORATORY MONTHLY PROGRESS REPORT FOR JUNE 1961 [ON CHEMISTRY]. J. F. Eichelberger (Mound Lab., Miamisburg, Ohio). June 30, 1961. Contract AT-33-1-GEN-53. 17p.

Plastic Research. The tensile strength of Dacron-filled diallyl phthalate was determined to average 4377 psi. Composition and stress-strain data are tabulated for ten adhesive films. Analytical studies of an adhesive exudate are reported. Radioelements. Results of analysis of ionium-bearing raffinate and residues for  $Th^{232}$  and of aged  $Ra^{223}$  for  $Ac^{227}$  are given. Progress on Pa recovery from raffinates and residues and separation from Nb is reported. Isotope Separation and Purification. Proposed work on gas centrifugal and photochemical separation of uranium isotopes is discussed. Progress on xenon and helium isotopes separation and purification is outlined. Reactor Fuels and Materials Development. The density of liquid La at 945 to 1000°C was determined. The performances of an oscillating cup viscometer with La and Bi and of a high-temperature calorimeter with  $Po^{210}$  are described. A study of the compatibility of Haynes 25 alloy with Pu at 900°C indicated that very little penetration took place after the first hour at 900°C. The efficiency of escape of  $\alpha$  particles from a glass fiber containing 10 wt % Pu oxide was determined to be ~72%. Eight glass compositions were evaluated for their ability to dissolve 15 wt % Pu oxide at 1650°C. A glass neutron standard containing Pu and Be oxides was prepared. (D.L.C.)

**32069** (NP-10813) RESEARCH ON SYNTHESIS OF 1000°F STABLE BASE FLUIDS. First Quarterly Progress Report, March 1, 1961-May 31, 1961. J. W. Dale, E. A. McElhill, and G. J. O'Neill (Monsanto Research Corp. Boston Labs., Everett, Mass.). Aug. 18, 1961. Contract AF33(616)-7853. 30p. (MRC-2018)

Research was mainly directed toward perfluoropolyaromatic structures for use as highly thermally stable base stock fluids. The Simons electrochemical method was found to be a good route to the production of  $C_6F_6$  in quantity. In the  $CoF_3$  fluorination process, attempts to prepare pure perfluorocarbons were not too successful; however, perfluorofluoranthane was purified from  $H_2$  and found to have a thermal stability of 1001°F. Eleven non-fluorinated compounds were treated for thermal stability; 2,4,5-triphenylthiazole showed the greatest stability (897°F). (D.L.C.)

**32070** (ORNL-3176) CHEMISTRY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1961. (Oak Ridge National Lab., Tenn.). Oct. 10, 1961. Contract W-7405-Eng-26. 117p.

Progress in the fields of nuclear chemistry, isolation and chemical properties of synthetic elements, chemical separation of isotopes, radiation chemistry, organic chemistry, chemistry of aqueous systems, electrochemistry of corrosion, nonaqueous systems at high temperature, and chemical physics for the year ending June 20, 1961, is reported. Separate abstracts were prepared for each topic. (M.C.G.)

**32071** (ORNL-3176(p.12-16)) ISOLATION AND CHEMICAL PROPERTIES OF SYNTHETIC ELEMENTS. G. E. Boyd, Q. V. Larson, et al. (Oak Ridge National Lab., Tenn.).

Isoopiestic vapor-pressure measurements of aqueous solutions of  $\text{NaClO}_4$ ,  $\text{NaTcO}_4$ , and  $\text{NaReO}_4$  over the concentration range 0.1 to 5.2 m showed that the latter two salts behaved as strong electrolytes, as was expected. The sequence of the computed molal osmotic coefficients was  $\text{NaClO}_4 > \text{NaTcO}_4 > \text{NaReO}_4$  at all concentrations. Absorption bands or groups of absorption bands of  $\text{ReX}_6^{2-}$  and  $\text{TcX}_6^{2-}$  ions ( $X = \text{F}, \text{Cl}, \text{Br}, \text{I}$ ) were assigned to certain energy levels expected to arise from a ligand field of octahedral symmetry surrounding the  $\text{Re}^{4+}$  or  $\text{Tc}^{4+}$ . However, the numbers of bands in two of the groups give evidence for a ligand field of lower than cubic symmetry. The fundamental crystal-field splittings,  $10Dq$ , are linear functions of the atomic number of the halogen for each of the  $\text{ReX}_6^{2-}$  and  $\text{TcX}_6^{2-}$  complex ions. Two equilibria were demonstrated to be involved in the reduction by stannous sulfate of heptavalent rhenium in concentrated sulfuric acid to hexavalent rhenium. The hexavalent rhenium is present as a monomer and a dimer, with  $K_1 = [\text{dimer}]/[\text{monomer}]^2 = 140$ . The hexavalent rhenium also disproportionates into penta- and heptavalent rhenium:  $K_2 = [\text{Re(V)}][\text{Re(VII)}]/[\text{Re(VI)}_{\text{monomer}}]^2 = 3.1$ . The calculated spectra of the hexavalent monomer and dimer are presented for the spectral range 4000 to 8000 Å. (auth)

**32072** (ORNL-3176(p.39-44)) ORGANIC CHEMISTRY. R. W. Spayd, C. J. Collins, et. al. (Oak Ridge National Lab., Tenn.).

The benzilic acid rearrangements of alloxan and several of its derivatives were studied with isotopic tracer methods. It was unambiguously established that the nitrogen-carbon shift takes place to the exclusion of the carbon-carbon shift. The migratory aptitude of  $\text{N-CH}_3$  vs  $\text{N-H}$  is about 4:1. The differential method developed for studying isotope effects was used in determining the values of some secondary isotope effects on  $\text{C}^{14}$  and deuterium during the formation of the 2,4-dinitrophenylhydrazones of several isotopically substituted ketones. The compound erythro-1-amino-1-phenyl-2-p-methoxyphenylpropanol-2 was resolved, and the (+) and (−) forms were subjected to deamination. The fractions of ketonic product of inverted and retained configurations were nearly identical with those previously determined during deamination of sterically similar compounds. The study of interactions in aqueous systems that are in equilibrium with organic solvents continued. Tributyl phosphate supported on Celite 545 (a free-flowing solid) had the same solubility in aqueous solutions as did liquid tributyl phosphate. The polyvalent electrolyte was accompanied by water when it was extracted into tributyl phosphate; strong specific interactions were indicated by high molecular weight and high viscosity. Equilibria between aqueous nitric acid and butyl p-toluene sulfonate (a weaker solvent than tributyl phosphate) showed that water (0.7 mole per mole of sulfonate) accompanies nitric acid into this system. (auth)

**32073** (ORNL-3176(p.45-59)) CHEMISTRY OF AQUEOUS SYSTEMS. R. M. Rush, J. S. Johnson, Jr., et. al. (Oak Ridge National Lab., Tenn.).

Equilibrium ultracentrifugations of hydrolyzed U(VI)

chloride solutions indicated that the "core-link" mechanism proposed on the basis of pH measurements is not tenable. A scheme involving a hydrolyzed monomeric, dimeric, and trimeric species was found to be compatible both with acid-base titration data and with the molecular weight measurements. A test of equilibrium ultracentrifugation in the determination of solute activity coefficients in the "known" three-component system  $\text{BaCl}_2\text{--HCl--water}$  indicated possible value of the technique for this purpose. Rules were found for correlating volumes and refractive-index increments for the same system with the values for the two-component systems  $\text{BaCl}_2\text{--water}$  and  $\text{HCl--water}$ . In continuation of studies of ion exchange resins and their application to separations, the cation exchange behavior of 53 elements in concentrated  $\text{HCl--HClO}_4$  mixtures was investigated. The mixed-acid system was particularly useful for group separations of elements by column techniques. Boric acid is useful as a complexing agent for HF in anion exchange separations involving concentrated  $\text{HCl--HF}$  media. Adsorbabilities of a number of divalent and trivalent elements in acid media were determined for zirconium phosphate and zirconium oxide. A number of separations of trivalent elements from divalent elements were demonstrated. Mercuric sulfide was found to exhibit rather unusual adsorptive properties. Small columns of HgS adsorbed large amounts of  $\text{Hg}(\text{NO}_3)_2$  from aqueous solutions, forming a white double salt. This double salt showed a high selectivity for halide ions. Liquid ion exchangers were found especially useful for researchers on the mechanisms of ion exchange, because the nature of the ions they take up from aqueous electrolyte mixtures may be studied by spectrophotometric, magnetic susceptibility, and other physical methods more readily than is the case with resinous exchangers. The nature of the chloro- and bromo-complex anions formed by some of the metals in the 3d transition series was determined by examining their optical absorption bands when they were present in a liquid anion exchanger prepared by dissolving small amounts of tertiary alkylamine in toluene. The typical "ligand field" spectra of the complexes of Fe, Co, Cu, and Mn were observed, and it was concluded that the species selectively taken up by anion exchangers were four-coordinated:  $\text{FeCl}_4^-$ ,  $\text{FeBr}_4^-$ ,  $\text{CoCl}_4^{2-}$ ,  $\text{CuCl}_4^{2-}$ ,  $\text{CuBr}_4^{2-}$ , and  $\text{MnCl}_4^{2-}$ . The preference of the exchanger for four- rather than for six-coordinated anions from aqueous solutions was considered to be a consequence of the fact that usually the latter contain water as a ligand and because, for the same ionic charge, octahedral anions are larger than the tetrahedral or square planar types. Relative apparent molal heat-content differences derived from measurements of heats of solution and dilution on aqueous solutions of quaternary ammonium halides structurally analogous to the exchange groups in Dowex 1 and Dowex 2 ion exchange resins were found to agree well with previously measured heats of anion exchange on the more highly cross-linked exchangers. However, with the lightly cross-linked resins, the exchange heat was significantly larger than the electrolyte heat-content difference. Heat-of-mixing measurements with linear cationic polyelectrolyte showed that even in dilute solutions these compounds reacted with ions as if they were effectively at a high concentration. This observation is consistent with the behavior of weakly cross-linked exchangers whose molecular chains must also be at an effectively high concentration. A non-linear least-squares method for fitting osmotic coefficient data to a semiempirical equation was investigated. From the coefficients so obtained, it is possible to compute activity coefficients over a wide range of concentrations. The method is greatly to be preferred over graphical integra-



tion if a high-speed computer is available to perform the calculations. The bisulfate acid constant was computed from 25 to 225°C from data on the solubility of  $\text{Ag}_2\text{SO}_4$  in  $\text{H}_2\text{SO}_4$  solutions. The value of  $K_2$  at 25°C agrees very well with the values reported by other investigators. The thermodynamic constants  $\Delta F^0$ ,  $\Delta H^0$ , and  $\Delta S^0$  for the reaction  $\text{HSO}_4^- = \text{H}^+ + \text{SO}_4^{2-}$  were also computed over the same temperature range. A beginning was made on writing an IBM 7090 computer program for solvent extraction involving an aqueous-nitrate and a TBP-containing organic phase. A second prototype high-temperature aqueous spectrophotometric cell, designed to allow gas-liquid equilibration, was used to study the system  $\text{UO}_2\text{SO}_4\text{--CuSO}_4\text{--D}_2\text{SO}_4\text{--D}_2\text{O--H}_2\text{O}$  in the wavelength range from 0.34 to 1.2  $\mu$  as a function of time, temperature, and overpressure of hydrogen and/or oxygen. (auth)

**32074** (ORNL-3176(p.68-76)) NONAQUEOUS SYSTEMS AT HIGH TEMPERATURE. G. W. Parker, G. E. Creek, et. al. (Oak Ridge National Lab., Tenn.).

A comparison was made of the extent of fission product release from  $\text{UO}_2$ -containing reactor fuels by the following mechanisms: oxidation in air, high-temperature diffusion in the solid, and melting in air, helium, or  $\text{CO}_2$ . These might be operative in loss-of-coolant accidents under various conditions. Release experiments demonstrating the effect of irradiation level or burnup conformed to the expected pattern in that generally increased releases were observed in highly irradiated samples over the values at tracer irradiation level. The specific electrical conductivity in the melts of three rare-earth and two alkaline-earth metal-metal chloride systems was determined. The increase in conductivity in  $\text{La--LaCl}_3$  and  $\text{Ce--CeCl}_3$  on addition of metal to the normal chloride was essentially due to electronic contribution from  $\text{M}^{2+} \rightarrow \text{M}^{3+} + e^-$ , but in  $\text{Nd--NdCl}_3$ , where the increase is much smaller, Nd dissolved as a stable  $\text{Nd}^{2+}$  ion. The results in the systems  $\text{Ca--CaCl}_2$  and  $\text{Sr--SrCl}_2$  were interpreted in terms of partially electronic conductance and formation of  $(\text{Ca}_2)^{2+}$  and  $(\text{Sr}_2)^{2+}$  ions. The increase in the resistivity of liquid potassium on dissolution of potassium halides was found to be roughly proportional to the cross section as well as the number of the halide ions which act as scattering centers for mobile electrons. (auth)

**32075** (ORNL-3176(p.77-93)) CHEMICAL PHYSICS. Henry Zeldes, Ralph Livingston, et. al. (Oak Ridge National Lab., Tenn.).

In a paramagnetic resonance study of irradiated potassium nitrate single crystals, the spectra for two species having  $\text{N}^{14}$  hyperfine splittings were measured. In gamma-irradiated single crystals of sodium nitrite and of sodium nitrite containing silver nitrite, the same paramagnetic resonance spectrum was seen, but with much higher intensity in crystals containing  $\text{AgNO}_2$ . The spectra are attributed to oriented molecules of  $\text{NO}_2$  in the lattice of  $\text{NaNO}_2$ . In gamma-irradiated single crystals of potassium chlorate, one paramagnetic species exhibiting chlorine hyperfine structure was tentatively identified as chlorine dioxide. Anomalous neutron scattering from  $\text{CdI}_2$  and enriched  $\text{Cd}^{113}\text{I}_2$  single crystals was observed. The magnitudes and energy dependence of the real and imaginary components of the scattering amplitude of cadmium are quantitatively predictable from the appropriate resonance parameters, using the Breit-Wigner single-level formulation. Neutron diffraction patterns of powder specimens and rotating single crystals were recorded photographically by means of a device that utilizes high-speed Polaroid film and a neutron-sensitive phosphor ( $\text{ZnS--Li}^9\text{F--Lucite}$ ). The time for most exposures is a fraction of the time required previously, and

the development time is 10 sec. A neutron diffraction study of  $\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$  showed the water molecule to be very weakly hydrogen-bonded to the oxygen atom ( $\text{O}_6$ ) of an equivalent water molecule ( $\text{O}_5\text{--O}_6 = 2.95 \text{ \AA}$ ) and to an oxygen atom ( $\text{O}_1$ ) of the sulfate ion ( $\text{O}_5\text{--O}_1 = 2.86 \text{ \AA}$ ). The  $\text{O}_5\text{--H}_2 \cdots \text{O}_6$  and  $\text{O}_5\text{--H}_1 \cdots \text{O}_1$  angles are  $150.9 \pm 1.1^\circ$  and  $151.8 \pm 2.8^\circ$  respectively. The dimensions of the water molecule are:  $\text{O}_5\text{--H}_1 = 0.94 \pm 0.02 \text{ \AA}$ ,  $\text{O}_5\text{--H}_2 = 0.97 \pm 0.04 \text{ \AA}$ ,  $\text{H}_1\text{--H}_2 = 1.56 \pm 0.04 \text{ \AA}$ , and  $\angle \text{H}_1\text{--O}_5\text{--H}_2 = 110.4 \pm 2.1^\circ$ . The R-factor (for  $F^2$ ) based on 240 (h0l) and (0kl) reflections is 7.1%. A neutron diffraction study to determine the crystal structure and molecular geometry of hydrazine is in progress. An x-ray study of hydrazine hydrate indicated that it has a cubic structure, with freely rotating or disordered  $\text{H}_2\text{O}$  and  $\text{N}_2\text{H}_4$  molecules. The coherent neutron scattering cross sections of  $\text{Rb}^{85}$  and  $\text{Rb}^{87}$  were found to be essentially alike,  $6.1 \pm 0.3$  barns. The total cross sections of these isotopes and those of  $\text{Cl}^{35}$  and  $\text{Cl}^{37}$  were found to be 7.45, 8.7, 47.45, and 3.9 barns respectively. In connection with a study of hydrogen bonding, the cell parameters and space groups of potassium, rubidium, and cesium acid chloromaleate single crystals were determined by x-ray diffraction. The structure of the cubic, high-temperature form of calcium carbide is discussed in terms of various models based on x-ray and neutron diffraction measurements. Of the four cooperative transitions exhibited by  $\text{K}_2\text{ReCl}_6$  with heat capacity maxima at 11.9, 76, 103, and 111°K, only the one at the lowest temperature is the result of a magnetic transition. It is estimated that an entropy of  $R \ln 2$  is associated with each of the remaining transitions. At 25°C the entropy of  $\text{K}_2\text{ReCl}_6(\text{c})$  is 88.84 cal deg $^{-1}$  mole $^{-1}$ , the entropy of  $\text{ReCl}_6^{2-}(\text{aq})$  is 59.8, and the entropy of formation is -140.2. It was found possible to calculate the liquid-soluble, solid-insoluble impurity content of  $\text{Li}_3\text{ThF}_7$  from careful heat-content measurements with the Bunsen ice calorimeter in the premelting region. Progress in the study of reactive collisions of hydrogen atoms and of alkali atoms is discussed. It was demonstrated that beta particles from  $\text{Ni}^{63}$  can be used as an ionization source in a mass spectrometer. The relative proportions of the primary and secondary ions produced in ethylene were investigated as a function of pressure in the ionization chamber. When 3.1-kev electrons were used to bombard either argon or krypton as a mass spectrometer, positive ions ranging in charge from one through eight were observed in both gases, and the relative proportions of the ionic species bore a marked similarity to those of the multiply charged ions resulting from  $\beta^-$  nuclear transitions. (auth)

**32076** (ORNL-3183) THE CALCINATION IN AIR OF BERYLLIUM OXALATE TRIHYDRATE TO BERYLLIUM OXIDE. R. L. Hamner and L. A. Harris (Oak Ridge National Lab., Tenn.). Oct. 19, 1961. Contract W-7405-eng-26. 16p.

Variations in sinterability of high-purity  $\text{BeO}$  powders obtained by calcining  $\text{BeC}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$  led to an investigation of the phase changes occurring during the calcination process. Studies were made under continuous and equilibrium heating conditions, using differential thermal analysis, thermogravimetric measurement, and room- and high-temperature x-ray analysis. Beryllium oxalate trihydrate decomposed to  $\text{BeC}_2\text{O}_4 \cdot \text{H}_2\text{O}$  when heated in air at 50°C, given sufficient time. A liquid phase was observed during decomposition to  $\text{BeC}_2\text{O}_4 \cdot \text{H}_2\text{O}$  under rapid heating conditions between 80 and 150°C; this effect was not observed under "equilibrium" heating conditions at 100°C or below. The monohydrate was observed to decompose between 225 and 250°C. Complete decomposition to  $\text{BeO}$  was accomplished at 275°C and might occur as low as 250°C. No stable

intermediate compounds except  $\text{BeC}_2\text{O}_4 \cdot \text{H}_2\text{O}$  were indicated during the calcination process. (auth)

**32077** (UCRL-9733) NUCLEAR MAGNETIC RESONANCE STUDIES. PART I:  $\text{H}^1$  TEMPERATURE-DEPENDENT CHEMICAL SHIFTS. PART II:  $\text{F}^{19}$  SPIN-SPIN COUPLINGS (thesis). Leonidas Petrakis (California, Univ., Berkeley, Lawrence Radiation Lab.). June 6, 1961. Contract W-7405-eng-48. 89p.

The temperature dependence of the proton chemical shifts of various gaseous compounds was investigated. It was found that the chemical shifts of most of these compounds vary with temperature. This effect was ascribed to excitation of vibrational modes of the molecules, the protons in the excited molecules being differently shielded than the protons in the molecules in the ground vibrational states. The data were interpreted to yield approximate chemical shifts associated with the excitation of various types of vibrational modes. Nuclear magnetic resonance (NMR) isotopic shifts are discussed on the basis of these data. The  $\text{F}^{19}$  NMR spectra of certain saturated organic compounds were investigated. It was found that generally the spin coupling constant between 1, 2 fluorine atoms  $J_{1,2}$  approximates 0 cps, and that  $J_{1,3}$  approximates 7 to 10 cps, if all intermediate skeletal atoms are carbon atoms;  $J_{1,3}$  approximates 10 to 17 cps if one of the intermediate skeletal atoms is a nitrogen atom; and  $J_{1,4}$  approximates 2 to 7 cps. A critical examination of the "long range" spin-spin interaction between fluorine atoms is given. It is shown that, in contradistinction to coupling between protons, magnetic dipolar and electron orbital terms must play an important part in the coupling mechanism between fluorines; and that "long range" coupling takes place through space by the formation of a long bond between the interaction atoms, rather than the interaction being "telegraphed" via the intervening chemical bonds. (auth)

**32078** (AEC-tr-4838) ON THE PREPARATION AND PROPERTIES OF MELLITIC ACID. M. Chaigneau. Translated by L. M. Ferris (Oak Ridge National Lab., Tenn.) from Ann. chim. (Paris) (13), 1: 381-98(1956). 17p.

The preparation and properties of mellitic acid (benzenehexacarboxylic acid) are reviewed. Mellitic acid is a juxta-nuclear hexacid which is found in nature in the form of mellite and is formed by the direct oxidation of C. Reactions are described which permit the characterization of mellitic acid using relatively small samples. (C.H.)

**32079** (AEC-tr-4839) CRYSTAL CHEMISTRY OF THE OXYGEN COMPOUNDS OF VANADIUM, TUNGSTEN AND MOLYBDENUM. R. P. Ozerov. Translated from Uspekhi Khim., 24: 951-84(1955). 59p.

The structure of almost all of the oxides of V, Mo, and W and also the structure of a number of the bronzes, were found to consist of deformed octahedra. The method of coordinated polyhedra developed by Belov was applied to the study of the oxide structures. The structures of the individual oxides and their systems were determined. A study was also made of the W and V bronzes. Methods of preparation of the bronzes are outlined. Na and Li tungsten bronzes with a perovskite type structure and tetragonal II tungsten bronzes are discussed. Properties of the W and V bronzes including electrical conductivity, color, catalytic properties, and magnetic susceptibility are described. (M.C.G.)

**32080** (AEC-tr-4849) ON EUCHROIC ACID. Marcel Chaigneau. Translated by L. M. Ferris (Oak Ridge National Lab., Tenn.) from Compt. rend., 240: 2324(1955). 3p.

The action of heat on ammonium mellitate was studied.

The salt was heated in a quartz tube containing sodium chips in the portion which protruded from the furnace. Under these conditions it was possible to collect a gaseous mixture containing the evolved ammonia and the hydrogen arising from the reaction of water vapor with the sodium. The residue consisted of equal parts of paramide, or mellimide, and ammonium euchroate. A study was then carried out to determine if the positions of the carboxyls in the euchroic acid were ortho or para. Results indicated that they were in the para position. (M.C.G.)

**32081** (NP-tr-783) EXTRACTION OF RUBIDIUM AND CESIUM FROM MINERALS AND ORES. F. M. Perel'man. Translated from p.103-29 of Rubidii i Tsezii (A publication of the Publishing House of the Academy of Sciences, Moscow, 1960). 42p.

A review is presented of methods used in the extraction of cesium and rubidium from lepidolites, pollucites, carnallites, and low-concentration phosphates and silicates. The production and electrochemical properties of cesium and rubidium are reviewed. (B.O.G.)

**32082** (UCRL-Trans-707) ON THE BASIC ELECTRON STATE OF OXIDES OF MOLECULES OF GROUP II ELEMENTS. I. V. Veits and L. V. Gurvich. Translated by D. A. Nimidoff (Univ. of California Lawrence Radiation Lab., Berkeley) from Optika i Spektroskopiya, 2: No. 2, 145-9(1957). 14p.

As a result of the study of the relation of the logarithm of the dissociation equilibrium constant of  $\text{CaO}$  and  $\text{SrO}$  with temperature in the interval from 2300 to 3200°K, the dissociation energies of the molecules were determined. On the basis of a comparison of the magnitudes found and by the equation  $D_0 = T(\Delta\phi^* - R \ln K_p)$ , a deduction was made that the state of the molecules of both oxides must be the  $^1\Sigma$  state. It is shown that this supposition is not contrary to the rules of correlation of the basic conditions of the corresponding molecules correlate with the excited  $^3P$ -condition of the metal atom. The potential curves of the triplet conditions formed by the basic conditions of the atoms of the metal and oxygen  $^1S(M) + ^3P(O)$  were found to be curves of the repulsion types. (auth)

**32083** CHEMISORPTION. Proceedings of a Symposium held at The University College of North Staffordshire, Keele, Staffordshire by The Chemical Society, 16-19 July 1956. W. E. Garner, ed. New York, Academic Press Inc. and London, Butterworths Scientific Publications, 1957. 284p.

Proceedings of the Symposium on Chemisorption are presented. Twenty-three papers on the theory of chemisorption and chemisorption on insulators, metals, semiconductors, and carbon are included. Separate abstracts were prepared for four papers. (M.C.G.)

**32084** THE SURFACE CHEMISTRY OF URANIUM AND THORIUM OXIDES. J. D. M. McConnell and L. E. J. Roberts (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.218-26 of "Chemisorption," New York, Academic Press Inc. and London, Butterworths Scientific Publications, 1957.

An account is given of many of the reactions of oxygen, carbon monoxide, and hydrogen with uranium dioxide and thorium dioxide and solid solutions of these two oxides. Carbon monoxide is adsorbed on both uranium and thorium sites at low temperatures, while oxygen is adsorbed only on uranium sites, one molecule reacting with one surface uranium atom. Hydrogen is chemisorbed on oxygen sites at high temperatures, and carbon is deposited from carbon monoxide at high temperatures and high pressures. (auth)



## Analytical Procedures

*Refer also to abstracts 32308 and 32656*

**32085** (ANL-6368(p.83)) PRELIMINARY REPORT: SPECTROPHOTOMETRIC TITRATION OF DEOXYRIBONUCLEIC ACID. L. G. Bunville (Argonne National Lab., Ill.).

Preliminary results are reported from potentiometric and differential spectrophotometric titrations of deoxyribonucleic acid (DNA) samples of varying composition. Applications in elucidation of the transition of DNA in acid solutions are discussed. (C.H.)

**32086** (ANL-6368(p.100-3)) S-ADENOSYLMETHIONINE IN RAT LIVER. Panpit Pansuwana (Argonne National Lab., Ill.).

Procedures are described for the determination of S-adenosylmethionine in tissues. Results are included from measurements of the concentration of S-adenosylmethionine in rat liver and tracer studies carried out to check for the presence of methionine reserves in liver. (C.H.)

**32087** (ANL-6368(p.159-61)) A DIFFICULTY WITH IODOMETRIC TECHNIQUES APPLIED TO CERTAIN PEROXIDE MIXTURES. R. N. Feinstein (Argonne National Lab., Ill.).

In classical iodometry, an excess of KI is added to the acidified sample, together with a drop of 5% ammonium molybdate, and the free iodine released is titrated with standard  $\text{Na}_2\text{S}_2\text{O}_3$ . This technique was used with complete satisfaction in the analysis of pure solutions of  $\text{H}_2\text{O}_2$ , disuccinoyl peroxide (DSP), or quinone, but considerable difficulty has been encountered in applying it to mixtures of  $\text{H}_2\text{O}_2$  or DSP with quinone, or to an  $\text{H}_2\text{O}_2$ -hydroquinone-copper system. The difficulty takes the form of a delayed, recurrent end point. Data are tabulated on the effect of acid on end point recurrence. (auth)

**32088** (CEA-1792) MISE AU POINT D'UNE TECHNIQUE DE PREPARATION D'ECRANS D'URANIUM POUR LA SPECTROGRAPHIE DE RAYONS X MOUS. (Development of a Technique of Preparation of Uranium Screens for Soft X Ray Spectrography). L. de Bersuder (Paris. Universite. Laboratoire de Chimie Physique). 1961. 56p.

Work is reviewed on the preparation of thin layers of pure uranium, thickness 100 to 1000 Å, by thermal evaporation under vacuum. The protection of uranium against oxidation is obtained by using aluminum deposits under and above the uranium layer. The purity of the layers obtained is checked by electron diffraction and the necessary conditions to avoid oxidation and alloy formation during the formation of deposit are studied. Three methods for measuring the thickness are examined: by  $\alpha$  particle counting, by weighing the condensed mass, and by weighing the evaporated mass. The method using  $\alpha$  particle counting was the most accurate for low thickness layers. (auth)

**32089** (DP-627) SPECTROCHEMICAL ANALYSIS IN A LITHIUM CARBONATE MATRIX. Douglas H. Purcell and J. Allen Wheat (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Sept. 1961. Contract AT(07-2)-1. 12p.

Spectrochemical analysis of unknown samples in a lithium carbonate matrix, with photometric measurement of line intensities, was shown to yield reasonably precise and accurate results for a wide range of elements. When twenty-eight elements were determined by this technique, starting

with a wide variety of sample forms, the coefficients of variation for about 0.2% concentration were less than 30% for twenty-four of the elements. (auth)

**32090** (IA-672) DETERMINATION OF BORON IN ALUMINIUM METAL. K. Rosenberg (Israel. Atomic Energy Commission, Tel-Aviv). Aug. 1961. 11p.

A method for the determination of boron present in quantities higher than 100 ppm in metallic aluminum is described. The sample is dissolved in HCl and  $\text{H}_2\text{O}_2$  and the aluminum removed by cation-exchange. The boric acid formed is converted to its complex with mannitol and determined acidimetrically, using  $\alpha$ -naphtholphthalein as indicator. (auth)

**32091** (PG-Report-182) ANALYTICAL METHOD FOR THE DETERMINATION OF BERYLLIUM COLLECTED ON FILTER PAPER USING A DIRECT READING SPECTROMETER. (United Kingdom Atomic Energy Authority. Engineering Group, Windscale, Cumb., England and United Kingdom Atomic Energy Authority. Production Group, Windscale, Sellafield, England). 1961. 8p.

A method was developed for the determination of beryllium collected on a filter paper through which a known volume of air was drawn or which was used for a smear test. The sample was ignited and the residue digested with HCl and HF acids. The solution was then analyzed by the graphite spark technique using a three-channel integrating photometer. The precision of the method was  $\pm 30\%$  at 0.001  $\mu\text{g}$  Be and the concentration range was 0.0002 to 0.02  $\mu\text{g}$  per pair of electrodes. (M.C.G.)

**32092** (IID-14083) DETERMINATION OF OXYGEN BY FAST NEUTRON ACTIVATION ANALYSIS USING A LOW COST PORTABLE NEUTRON GENERATOR. Edgar L. Steele and W. Wayne Meinke (Michigan. Univ., Ann Arbor). [1961]. Contract AT(11-1)-70. 15p.

Fast neutron activation analysis, using a low cost Cockcroft-Walton design accelerator as a source of 14-Mev (deuterium-tritium) neutrons, was found to be satisfactory for trace oxygen analysis. This method is rapid, sensitive, and selective, and is free from most matrix interferences. It uses equipment costing no more than infrared or spectrographic instruments. Fast neutrons ( $>10$  Mev) convert  $\text{O}^{16}$  by an (n,p) reaction to 7.4-second  $\text{N}^{16}$ . This in turn emits 6-7 Mev gamma rays which are measured by scintillation spectrometry. Samples containing 10 mg or more of oxygen were analyzed to within  $\pm 10\%$  with a fast flux of  $\sim 10^8$  n  $\text{cm}^{-2}$   $\text{sec}^{-1}$ . Larger samples give smaller errors. By using all the sample area available with an average flux for irradiation of  $10^8$  n  $\text{cm}^{-2}$   $\text{sec}^{-1}$  and using a proper transfer system, it should be possible by this non-destructive method to analyze to within  $\sim \pm 10$  to 15% for as low as 10 ppm of oxygen. The average time for an analysis, including weighing, is approximately 7 minutes. The only interference encountered is from fluorine and this can be compensated for at F/O ratios below 10. (auth)

**32093** (USNRDL-TR-527) QUANTITATIVE RADIO-CHEMICAL ANALYSIS-SOLVENT EXTRACTION OF MOLYBDENUM-99. L. Wish (Naval Radiological Defense Lab., San Francisco). Sept. 12, 1961. 17p.

A method was developed for the rapid quantitative separation of  $\text{Mo}^{99}$  from fission product mixtures. It is based on the extraction of Mo into a solution of  $\alpha$ -benzoin oxime in chloroform. The main contaminants are Zr, Nb, and I. The first two are eliminated by complexing with fluoride and the third by volatilization or solvent extraction. About 5% of the  $\text{Te}^{99}$  daughter is extracted with its parent, and it is necessary to wait 48 hrs for equilibrium

to obtain an accurate  $\gamma$  ray counting result. The analysis of fission product mixtures by this method and a standard radiochemical gravimetric procedure showed agreement within 1 to 2%. (auth)

**32094** (NP-tr-775) APPLICATIONS OF THE SYSTEM  $\text{Cr}_2\text{O}_7^{--}: 2\text{Cr}^{+++}$  IN SPECTROPHOTOMETRIC ANALYSIS. F. Capitan García and M. Lachica Garrido. Translated by J. B. Sykes (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from *Anales real soc. espan. fis. y quim.* (Madrid), Ser. B, 52: 237-50 (1956). 30p. (Includes original, 10p.). (Handwritten MS. Copy).

The characteristics of the spectral curve of  $\text{Cr}_2(\text{SO}_4)_3$  were verified. Data are included on the effects of  $\text{H}_2\text{SO}_4$ ,  $\text{H}_3\text{PO}_3$ , temperature, stability of the dissolutions, the limits between which Beer's law is observed, interferences, and the effects of excess  $\text{Cr}_2\text{O}_7\text{K}_2$  on the spectrophotometric determination of  $\text{Cr}^{+++}$ . (C.H.)

**32095** SEPARATION OF MACRO QUANTITIES OF THORIUM WITH 2-THENOYLTRIFLUOROACETONE. T. C. Rains, Marion Ferguson, and H. P. House (Oak Ridge National Lab., Tenn.). *Anal. Chem.*, 33: 1645-7 (Nov. 1961).

The procedure for the extraction of thorium with 2-thenoyltrifluoroacetone (TTA) was modified, whereby gram quantities of thorium, free of the basic salts of TTA, can be extracted in a relatively short period of time. The pH of the solution is controlled during the extraction by addition of acetate solution of pH 4.5. Relatively large quantities of thorium are separated rapidly from many elements such as the members of the alkaline earth and rare earth groups. (auth)

**32096** DETERMINATION OF THORIUM IN LOW-GRADE ORES USING A CATION EXCHANGE SEPARATION-EDTA TITRATION PROCEDURE. F. W. E. Strelow (South African Council for Scientific and Industrial Research, Pretoria). *Anal. Chem.*, 33: 1648-50 (Nov. 1961).

The selective cation exchange separation of thorium on AG 50W-X12 resin is combined with a sensitive EDTA titration method using Xylenol Orange as indicator to determine thorium in low-grade ores. The end point is sharp when a back-titration with thorium solution is used. Small amounts of fluoride influence both the sharpness of the end point and the titration volume. Procedures for the determination of thorium in carbonates and in complex tantaloniobates are described. Interference from traces of ferric iron which blocks the indicator can be suppressed by reduction to the ferrous state with hydroxylamine hydrochloride. (auth)

**32097** COMPLEXOMETRIC DETERMINATION OF FLUORIDE WITH CERIU(III). Stanley S. Yamamura, Maxine Elliott Kussy, and James E. Rein (Phillips Petroleum Co., Idaho Falls, Idaho). *Anal. Chem.*, 33: 1655-7 (Nov. 1961).

A volumetric method is presented for the determination of fluoride in inorganic samples containing high levels of metal ions as well as the anions nitrate, chloride, and perchlorate. After preliminary separation of the fluoride by pyrolysis, cerous fluoride is precipitated stoichiometrically at pH 1.75 with a measured excess of cerium(III), and the excess cerium is back-titrated with EDTA to an arseneazocresol red end point. Sulfate and large amounts of borate interfere. (auth)

**32098** ANALYSIS OF THALLIUM AMALGAMS. William T. Foley and Judith M. Osyany (St. Francis Xavier Univ., Antigonish, Nova Scotia). *Anal. Chem.*, 33: 1657-8 (Nov. 1961).

A sample of thallium amalgam is dissolved in nitric acid

and, after removal of the mercury by precipitation with formic acid, the thallium is estimated either by titration with iodate or by a coulometric titration with electrogenerated bromine. An electrolytic method of preparing pure thallium sulfate is described. Formic acid is proposed as a reducing agent for thallium(III). (auth)

**32099** ULTRAVIOLET DETERMINATION OF URANIUM IN CONCENTRATED HYDROCHLORIC ACID. Clarence M. Callahan (U. S. Naval Radiological Defense Lab., San Francisco). *Anal. Chem.*, 33: 1660-4 (Nov. 1961).

A spectrophotometric method for determining microgram quantities of uranium in concentrated hydrochloric acid is given. The method is based on the absorbance of a chloride complex of uranium at 246  $\mu$ . Beer's law is obeyed in the uranium concentration range of less than 1 to 60 ppm. Interfering ions are removed by one or more extractions of the uranium into ethyl acetate using aluminum nitrate as a salting agent. The extent of interference of 55 ionic species after a single extraction is tabulated. The absorption spectra of uranium(VI) in concentrated hydrochloric, sulfuric, perchloric, and acetic acids are given. (auth)

**32100** IMPROVEMENTS IN THE FLUOROMETRIC DETERMINATION OF SUBMICROGRAM QUANTITIES OF BERYLLIUM. Claude W. Sill, Conrad P. Willis, and J. Kenneth Flygare, Jr. (U. S. Atomic Energy Commission, Idaho Falls, Idaho). *Anal. Chem.*, 33: 1671-84 (Nov. 1961).

A recently published procedure for the fluorometric determination of beryllium using morin was improved significantly, and its application was extended. Stabilization of alkaline solutions of morin toward air was accomplished without use of stannite or other reducing agents. Use of diethylenetriaminopentaacetic acid in place of (ethylenedinitrilo)-tetraacetic acid prevents formation of fluorescent complexes of morin with scandium, yttrium, and lanthanum, and increases the selectivity greatly. A new combination of primary and secondary filters produces a threefold increase in the ratio of net beryllium fluorescence to blank fluorescence while requiring an instrumental sensitivity only one fourth that obtained with the previous combination. Since the exciting wave lengths are entirely in the visible region of the spectrum, errors produced by colorless ions that absorb in the ultraviolet are eliminated. One of the most important discoveries was the extensive adsorption of beryllium from alkaline solution on the glass walls of the container. The fluorescent species contains beryllium and morin in a mole ratio of 1 to 1. Detailed procedures are presented for the determination of beryllium in metallic thorium, zirconium, uranium, copper alloys, and aluminum, in rare earth oxides and phosphates, and in silicates such as beryl and clay that are not decomposed completely by either pyrosulfate fusion or hydrofluoric acid. Beryllium can be determined in air dusts at concentrations well below the maximum permissible levels without separations of any kind in approximately 30 minutes. (auth)

**32101** DECOMPOSITION OF REFRACTORY SILICATES IN ULTRAMICRO ANALYSIS. Claude W. Sill (U. S. Atomic Energy Commission, Idaho Falls, Idaho). *Anal. Chem.*, 33: 1684-6 (Nov. 1961).

A procedure is described for the complete decomposition of mixtures of refractory silicates and oxides. A potassium fluoride fusion in a platinum dish is followed by addition of sulfuric acid and transposition to a pyrosulfate fusion in the same vessel. Fluorides and silica are volatilized simultaneously, and sample decomposition is so complete that all time consuming evaporations and filtrations are eliminated. Conventional glassware can be used in all subsequent steps and contamination from impure re-



agents or from corrosion of the container walls is reduced to a minimum. The decomposition is so rapid and effective and the contamination from environmental sources so small that the procedure can be used for the determination of submicrogram quantities of nonvolatile elements in siliceous materials. (auth)

**32102** USE OF VERY-SHORT-LIVED ISOTOPES IN ACTIVATION ANALYSIS. Oswald U. Anders (Dow Chemical Co., Midland, Mich.). *Anal. Chem.*, 33: 1706-9(Nov. 1961).

A new type of activation analysis is reported for tungsten, gold, silver, selenium, hafnium, fluorine, and oxygen, making use of their 5- to 24-second isotopes for counting. The concept of the  $\gamma$ -ray difference spectrum is applied to suppress longer-lived components in the gamma spectra of the activated samples. Analyses require less than  $\frac{1}{2}$  hour. As little as 1 ppm of hafnium can be detected. (auth)

**32103** X-RAY SPECTROGRAPHIC DETERMINATION OF THORIUM IN URANIUM ORE CONCENTRATES. W. C. Stoecker and C. H. McBride (Mallinckrodt Chemical Works, Saint Charles, Mo.). *Anal. Chem.*, 33: 1709-13(Nov. 1961).

Thorium is determined rapidly and precisely in uranium ore concentrates by an x-ray spectrographic measurement of the intensity at the  $\text{ThL}\alpha$  peak. The intensity is compared to that of the  $\text{UL}_1$  peak as an internal standard. Background interference due to the nearby  $\text{UL}\alpha$  peak is compensated by a simple mathematical correction applied to the intensity ratio. The variable (but accurately determined) internal standard compensates for differences in composition of ore concentrates from various sources, and the effects of the common contaminants are eliminated. No elements interfere at concentration levels ordinarily encountered. (auth)

**32104** PRELIMINARY STUDY OF THE QUANTOMETRIC DETERMINATION OF BORON IN LOW ALLOY STEELS. V. de Léo (Nazionale Cogne-Adsta, Italy). *Rev. met.*, 58: 605-8(1961). (In French)

A description of the technique used in the determination is given along with the constitution of the standard specimens, which must not contain W and Sn. Good results can be obtained when  $W \leq 5\%$ ,  $V \leq 0.80\%$ ,  $Mo \leq 1.30\%$ , and  $Ti \leq 0.50\%$ . (auth)

**32105** FLAME SPECTROPHOTOMETRIC STUDY OF BARIUM. John A. Dean (Univ. of Tennessee, Knoxville), J. C. Burger, T. C. Rains, and H. E. Zittel. *Anal. Chem.*, 33: 1722-7(Nov. 1961).

Flame emission characteristics of the barium ionic doublet at 455.4 and 493.4  $m\mu$ , the atomic resonance line at 553.6  $m\mu$ , and the BaOH and BaO bands at 488 and 513  $m\mu$  were studied. A prism flame spectrophotometer (Beckman DU) and a grating type (Jarrell-Ash Ebert) were used. Barium concentrations ranged from 1 to 10  $\mu\text{g}$  per ml (Jarrell-Ash Ebert) and 10 to 100  $\mu\text{g}$  per ml (Beckman). Effects of flows of oxygen and fuel (hydrogen and acetylene), ratio of these flows, different regions of flame mantle viewed, organic solvents, and various cations and anions were determined. With anionic interferences, the oxygen-acetylene has advantages over the oxygen-hydrogen flame; otherwise not. Spectral, condensed-phase, and radiation type interferences were investigated. Several elements interfere seriously. Flame spectrophotometry is rapid and is more sensitive and accurate than other methods for barium in the concentrations studied. (auth)

**32106** THE BASIS OF SELECTIVITY IN CHROMATOGRAPHY, ELECTROCHROMATOGRAPHY, AND CONTINUOUS ELECTROCHROMATOGRAPHY. Harold H. Strain

(Argonne National Lab., Ill.). *Anal. Chem.*, 33: 1733-7 (Nov. 1961).

The selectivity of separations by chromatography, electrochromatography, and continuous electrochromatography depends upon the substances being separated and upon the migration conditions. The number of these differential migration conditions is enormous and indeterminate. There is no common basis for comparing the selectivity of the separations, and there is no widely applicable basis for predicting the selectivity of particular systems. No systematic relationship between the separability and the molecular structure of various substances has been demonstrated. (auth)

**32107** SILICA GEL STRUCTURE AND THE CHROMATOGRAPHIC PROCESS. EFFECT OF PORE DIAMETER ON THE ADSORPTION AND DIFFERENTIAL MIGRATION OF STEROL ACETATES. Peter D. Klein (Argonne National Lab., Ill.). *Anal. Chem.*, 33: 1737-41(Nov. 1961).

A systematic study of six types of silica gels was undertaken to determine the role of gel pore diameter in the chromatographic resolution of sterol acetates. The gels were characterized in terms of surface area, pore volume, average pore diameter, and density. A criterion analogous to the plate concept in partition chromatography was developed for the evaluation of these silica gels in the adsorption chromatography of sterol acetates. From two independent avenues of approach it is possible to demonstrate that the utilization of surface area in the adsorptive process is dependent jointly on the average pore diameter and the molecular area of the adsorbate. The significance of the adsorbent structure in the chromatographic process is discussed. (auth)

**32108** EXTRACTION OF THE ELEMENTS AS QUATERNARY (PROPYL, BUTYL, AND HEXYL) AMINE COMPLEXES. William J. Maeck, Glenn L. Booman, Maxine Elliott Kussy, and James E. Rein (Phillips Petroleum Co., Idaho Falls, Idaho). *Anal. Chem.*, 33: 1775-80(Nov. 1961).

The distributions of 57 metallic ions were measured for three quaternary amines, tetrapropyl, tetrabutyl, and tetrahexyl, into methyl isobutyl ketone from five media,  $\text{HNO}_3$ ,  $\text{H}_2\text{SO}_4$ , HF, HCl, and NaOH, over the concentration range of 0.2 to 5N. Distribution data are presented as plots of per cent extraction vs. normality in a series of 5 periodic charts. Many separations for radiochemical and general analytical application are proposed. (auth)

**32109** SEPARATION OF ARSENIC FROM ANTIMONY AND BISMUTH BY SOLVENT EXTRACTION. H. C. Beard and L. A. Lyster (Florida State Univ., Tallahassee). *Anal. Chem.*, 33: 1781-2(Nov. 1961).

Benzene serves as a highly selective and sensitive extraction for arsenic(III) from hydrochloric acid medium. Above 8N in hydrochloric acid, essentially 100% of arsenic(III) is extracted. Separations from antimony and bismuth ions were investigated and checked using radioactive tracer techniques. The influence of hydrochloric acid concentrations on the extractability of arsenic(III) was investigated and found to be very critical. The procedure is rapid and yields accurate results. (auth)

**32110** THE SPECTROGRAPHIC DETERMINATION OF MOLYBDENUM IN URANIUM-MOLYBDENUM ALLOYS. Douglas H. Purcell (W. R. Grace and Co., Erwin, Tenn.). *Appl. Spectroscopy*, 15: No. 4, 101-3(1961).

Molybdenum was determined as an alloying constituent in uranium-molybdenum alloys by the point-to-plane spark method of spectrographic analysis. The method covers a concentration range of 1 to 5% molybdenum, and the pre-

cision at the 95% confidence level is  $\pm 7\%$ . Time required for the analysis of one sample is about fifteen min. (auth)

**32111** THE SPECTROGRAPHIC DETERMINATION OF URANIUM 235. PART IV. USING A DIRECT READING, LITTROW, GRATING SPECTROGRAPH AND A HOLLOW CATHODE. Ted Lee, Owen P. Killeen, and S. A. McIntyre (Oak Ridge Gaseous Diffusion Plant, Tenn.). *Appl. Spectroscopy*, 15: No. 4, 106-9(1961).

The use of a hollow cathode source and a 4-m, direct-reading, Bausch and Lomb high-resolution spectrograph for the isotopic analysis of uranium is described. A relative precision of  $\pm 3.0\%$ , expressed at the 95% confidence level, was obtained with naturally occurring uranium for a single cathode determination of  $U^{235}$  measured in twenty min. Evidence for a weak uranium line structure interfering with the  $U^{235}$  measurement is presented. Minor isotopes,  $U^{234}$  and  $U^{236}$ , present up to a few percent at the higher  $U^{235}$  concentrations, did not interfere with  $U^{235}$  measurements. Measurements of  $U^{234}$ , however, could not be made in the presence of high  $U^{235}$  concentrations, thereby limiting the determination of total uranium necessary for calculating the percent  $U^{235}$ . At the lower  $U^{235}$  concentrations, the concentrations of minor isotopes are generally too small to significantly affect the total uranium content of the sample. (auth)

**32112** ABSOLUTE MEASUREMENT OF THE ACTIVITY OF RADIONUCLIDES BY THE BETA-GAMMA COINCIDENCE METHOD WITH HIGH EFFICIENCY DETECTORS. STUDY OF INSTRUMENTAL COINCIDENCE. A. Gandy (Foundation Curie, Paris). *Intern. J. Appl. Radiation and Isotopes*, 11: 75-91(Sept. 1961). (In French)

An examination was made of the production of instrumental coincidences. Both chance and virtual coincidences are considered. Calculations made according to two different methods show that the mean frequency of occurrence of instrumental coincidences depends on the delay which may be imposed on the pulses from one channel compared with those from the other channel. The formulas which are deduced allow for this effect. The conclusions are then verified by experiment and the practical consequences of this examination are deduced. (auth)

**32113** RAPID METHOD OF IDENTIFICATION OF  $\beta$ -RAY EMITTERS AND OF  $\beta$ -RADIOACTIVE IMPURITY DOSAGE. Y. Le Gallic, J. Legrand, and B. Grinberg (Centre d'Etudes Nucleaires, Saclay, France). *Intern. J. Appl. Radiation and Isotopes*, 11: 92-100(Sept. 1961). (In French)

A simple method is described of radioactive analysis, which allows an accurate determination of maximal energies of  $\beta$ -emitters and detection and titration of radioactive impurities in radionuclides as well. The method which uses a plastic scintillator, is based on the fact that the curve obtained by plotting the number of pulses measured against the threshold is a straight line in the case of pure  $\beta$ -emitters. A simple relation is then derived between the data of this straight line and the maximal energy of the  $\beta$ -spectrum of the radionuclide under consideration. (auth)

**32114** THE DETERMINATION OF LOW RADON AND RADIUM CONCENTRATIONS IN LIQUIDS AND SLURRIES. J. D. Greig (Transvaal and Orange Free State Chamber of Mines Research Labs., Johannesburg). *Intern. J. Appl. Radiation and Isotopes*, 11: 101-7(Sept. 1961). (In English)

A rapid and simple procedure for the determination of low Rn and Ra concentrations in liquids and slurries is described. The method uses equipment available from air sampling. Activated carbon is used to concentrate the Rn

without the necessity of extreme temperature conditions, and the method is applicable over the range  $10^{-12}$  to  $10^{-6}$  c Rn/l. It is believed that this technique may be useful in other applications involving the concentration of volatile radioactive material, either alone or in the presence of non-volatile active material. Applications to mining are discussed. (auth)

**32115** ON THE ASSAY OF TRITIUM AS TRITIO-BUTANE. A. M. Downes and A. R. Till (C.S.I.R.O., Ian Clunies Ross Animal Research Lab., Parramatta, Australia). *Intern. J. Appl. Radiation and Isotopes*, 11: 154-7(Sept. 1961). (In English)

The technique described by Glascock for counting tritium as tritio-butane was examined for the effect of the Grignard reagent on results. Results show clearly that the exchange between  $Mg(OH)Br$  and the reacting TOH is fast enough to cause a lowering of the specific activity of the butane produced. It was concluded that differences between the observed and calculated results were possibly due to different exchange and reaction rates depending on the physical form of the dry Grignard reagent. Exposure of Grignard reagent to the atmosphere for even a few seconds was sufficient to produce significant errors in the specific activity of butane generated from small volumes of water. The absorption of moisture was approximately proportional to the exposure time up to 30 sec. (C.H.)

**32116** GEL-LIQUID EXTRACTION. II. THE SEPARATION OF METALLIC SPECIES USING ION EXCHANGE RESINS IN CONJUNCTION WITH WATER-IMMISCIBLE ORGANIC EXTRACTANTS. H. Small (Dow Chemical Co., Midland, Mich.). *J. Inorg. & Nuclear Chem.*, 19: 160-9(Sept. 1961). (In English)

A number of new metal separation techniques were developed which employ water swollen ion exchange resins in conjunction with water immiscible extractants. The application of these processes to the problem of rare earth separation is illustrative of their general principles. The work brought to light some of the problems attendant on using incompatible phases of this type and introduced means whereby their influence on separation efficiency may be minimized. (auth)

**32117** NON-DISPERSIVE X-RAY FLUORESCENCE ANALYSIS OF URANIUM-CONTAINING SOLUTIONS. K. J. H. Mackay (United Kingdom Atomic Energy Authority, Capenhurst, Chest., Eng.). *J. Inorg. & Nuclear Chem.*, 19: 171-4(Sept. 1961). (DEG-Report-205). (In English)

An americium-241 source was used in place of an x-ray generator. Examination of the spectrum of the americium source showed that, apart from a prominent escape peak in the region of 30 kev, the spectrum agreed satisfactorily with the previously published spectrum. With a modified source, the fluorescent spectrum of a 1% uranium solution clearly showed two prominent L-lines. The results of the analyses of uranium as a single component in 1.0 N nitric acid solution are tabulated and graphed. Taking the limit of detection nominally as one-tenth of background, the method has a detection limit in the region of 50 ppm. (P.C.H.)

**32118** DETERMINATION OF ZIRCONIUM IN PRESENCE OF COMMON METALS USING 2:5 DIHYDROXY p-BENZOQUINONE AND THE NATURE OF METAL COMPLEXES WITH THIS REAGENT. B. D. Jain and S. P. Singhal (Univ. of Delhi). *J. Inorg. & Nuclear Chem.*, 19: 176-7(Sept. 1961). (In English)

Only zirconium is precipitated from 1 N hydrochloric acid solution by 2:5 Dihydroxy p-benzoquinone in the pres-



ence of a large number of common metals. The insolubility of the metal chelates in common organic solvents indicates that these are polymeric in character. (auth)

**32119** PHYSICS AND TECHNOLOGY OF MASS SPECTROSCOPIC ANALYSIS. PART IV. Hans Voshage (Max-Planck-Institut für Chemie [Otto-Hahn-Institut], Mainz). *Kerntechnik*, 3: 399-404 (Sept. 1961). (In German)

The application of thermal surface ion sources presents considerable advantages for mass spectrometric investigations on a very large number of elements because the measurements can be performed with very small samples. As a good understanding of the ionization mechanism is indispensable for the full use of these possibilities, the physical principles of the method are described in detail. (auth)

**32120** DETERMINATION OF URANIUM AS PYROPHOSPHATE. F. M. Brewer (Inorganic Chemistry Lab., Oxford). *Nature*, 191: 1290-1 (Sept. 23, 1961).

A scheme of analysis is given for the determination of uranium as pyrophosphate. The green phosphate, which corresponds with 68.55% uranium, is first determined. Evaporation and ignition of the green phosphate dissolved in nitric acid leaves the yellow pyrophosphate  $(\text{UO}_2)_2\text{P}_2\text{O}_7$ , which contains 66.81% uranium. The latter body is excessively hygroscopic and difficult to weigh. (P.C.H.)

**32121** FAST METHOD FOR DETERMINING Th, Ra, AND Pb IN MONAZITES. K. S. Ivanova. *Radiokhimiya*, 3: 348-55 (1961). (In Russian)

A polarographic method is offered for directly determining lead in phosphate solutions of monazites. A method is also given for separating lead from phosphoric acid solutions. The accuracy of determinations of radium and thorium is verified. A scheme is included for determining age from one general monazite batch. (R.V.J.)

**32122** DETERMINATION OF Ra AND Ra ISOTOPES BY AMMONIUM FLUORIDE AND TETRA DERIVATIVES OF EDTA SODIUM SALT. S. G. Tseitlin and P. I. Bykov. *Radiokhimiya*, 3: 356-8 (1961). (In Russian)

A fast and efficient method is suggested for decomposing natural formations with high silica contents. The method is applied in determining radium and radium isotopes. (R.V.J.)

**32123** RADIOACTIVATION METHOD OF DETERMINING THE SUM OF RARE ELEMENTS, MANGANESE, NICKEL, COPPER, ANTIMONY, MOLYBDENUM, CADMIUM, AND GOLD IN LITHIUM COMPOUNDS. V. R. Negin, V. N. Zamyatina, M. A. Presnyakova, and L. A. Chikisheva. *Radiokhimiya*, 3: 473-7 (1961). (In Russian)

A radioactivation method was developed for simultaneously determining  $\text{Dy}^{165}$ ,  $\text{Mn}^{56}$ ,  $\text{Ni}^{65}$ ,  $\text{Cu}^{64}$ ,  $\text{As}^{76}$ ,  $\text{Au}^{198}$ ,  $\text{Sb}^{122}$ ,  $\text{Cd}^{115}$ , and  $\text{Mo}^{99}$  in lithium salts. The method allows separation of Dy from all other admixtures, resulting in  $\text{Dy}^{165}$  of radiochemical purity exceeding 99%. (R.V.J.)

**32124** INVESTIGATIONS OF NEPTUNIUM COMPLEXING WITH TRILON B (COMPLEXING OF Np(IV) WITH TRILON B). M. P. Mefod'eva. *Radiokhimiya*, 3: 506-8 (1961). (In Russian)

An electrophoretic method was used in determining neptunium(IV) complex anion formation with ethylenediaminetetraacetate ions at pH 2 to 2.5. The results were confirmed by spectrophotometric investigation. (R.V.J.)

**32125** SEPARATION OF Nb AND Ta BY EXTRACTION OF Nb-OXINITE AT LOW pH. M. Dular and L. Kosta ("Jozef Stefan" Inst., Ljubljana, Yugoslavia). *Vestnik Sloven. kemi. društva.*, 6: 59-64 (July-Dec. 1959). (In Yugoslavian)

It was found that Nb- and Ta-oxinates can be extracted by chloroform even at low pH. The extraction of Nb is greatly dependent on the composition of the solution and on the duration of the extraction. In the pH range 2.5 to 4.5 the extraction of Nb is nearly constant with a yield above 90%, if a low concentration of citric acid (up to 0.2M) is used. Under the same conditions the extraction of Ta is more dependent on pH, with a minimum at pH 3-4 when less than 5%. Ta-oxinates are taken up in the organic phase. Differing from solutions obtained from alkaline medium, the extracts from acid medium are practically colorless, which could show a difference of composition. (auth)

**32126** DETERMINATION OF SMALL AMOUNTS OF Zr IN ORES AND COMPLEX SYSTEMS. L. Kosta and L. Ravnik ("Jozef Stefan" Inst., Ljubljana, Yugoslavia). *Vestnik Sloven. kemi. društva.*, 6: 65-70 (July-Dec. 1959). (In Yugoslavian)

The method is based on the coprecipitation of zirconium as barium fluorozirconate and the use of Alizarine S as a reagent for the spectrophotometric determination. In the presence of larger quantities of aluminum an additional coprecipitation of zirconium on titanium hypophosphate is necessary. To the solution, a few drops of  $\text{TiCl}_4$  are added and the hypophosphates are precipitated from a strongly acid medium. The precipitate is converted to a hydroxides, which are then dissolved in HCl. Titanium and hypophosphate is eliminated by precipitating zirconium on lanthanum fluoride in the presence of barium ions. After dissolving the fluorides in perchloric acid and evaporation, the residue is taken up in HCl and the color is developed. The method has a broad field of application and has proved suitable for the analysis of minerals and ash from coal and red slurry, as well as the determination of Zr in Ti and U. (auth)

**32127** ELECTROLYTIC ENRICHMENT AND DETERMINATION IN TRACE ANALYSES. Zenon Kublik. *Wiadomości Chem.*, 15: 499-528 (1961). (In Polish)

A survey of electroanalytical methods based on a cathodic deposition with subsequent anodic stripping of determined metals is given. Some of the methods enable the determination of concentrations as low as  $1 \times 10^{-9}$  M. (auth)

**32128** GRAVIMETRIC DETERMINATION OF SCANDIUM BY MEANS OF BENZENESULFINIC AND BENZENESULPHINIC ACIDS. I. P. Alimarin and N. V. Shakhova (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, Moscow). *Zhur. Anal. Khim.*, 16: 412-16 (July-Aug., 1961). (In Russian)

Benzenesulfinic acid and its ammonium salt forms with scandium a white crystalline precipitate in neutral and weak acid solutions. The composition of the compound corresponds to the formula  $\text{Sc}(\text{C}_6\text{H}_5\text{SeO}_2)_3$ , which may be recommended as a gravimetric form (a conversion factor for scandium is 0.0738). A method was developed for the determination of scandium by its precipitation with benzenesulfinic acid in the presence of rare earths, iron, and aluminum. The composition of the precipitate is close to the formula  $\text{Sc}(\text{C}_6\text{H}_5\text{SO}_2)_3 \cdot x\text{H}_2\text{O}$ . For the quantitative determination the precipitate is ignited at 1000° and weighed as  $\text{Sc}_2\text{O}_3$ . (auth)

**32129** THERMOGRAVIMETRY IN ANALYTICAL CHEMISTRY. COMMUNICATION 3. THERMOGRAVIMETRIC STUDY OF LANTHANUM CARBONATE. Yu. S. Sklyarenko, I. S. Sklyarenko, and T. M. Chubukova (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, Moscow). *Zhur. Anal. Khim.*, 16: 417-21 (July-Aug. 1961). (In Russian)

The formation of normal lanthanum carbonate  $\text{La}_2(\text{CO}_3)_3 \cdot n\text{H}_2\text{O}$  in the system:  $\text{LaCl}_3 - \text{Me}_2\text{CO}_3 (\text{Me} = \text{K}^+, \text{NH}_4^+) - \text{H}_2\text{O}$  was proved by the thermogravimetric method. The thermal dissociation follows the steps:  $\text{La}_2(\text{CO}_3)_3 \cdot n\text{H}_2\text{O} \rightarrow \text{La}_2(\text{CO}_3)_3 \rightarrow \text{La}_2\text{O}_3 \cdot \text{CO}_2 \rightarrow \text{La}_2\text{O}_3$ . The thermal stability was determined for  $\text{La}_2(\text{CO}_3)_3$  (300 to 400°) and for  $\text{La}_2\text{O}_3 \cdot \text{CO}_2$  (550 to 675°). The compound  $\text{La}_2\text{O}_3 \cdot \text{CO}_2$  is recommended for use as a gravimetric form for the determination of lanthanum. The most suitable precipitant is ammonium carbonate. The ignition temperature must be 600°. (auth)

**32130** PHOTOMETRIC DETERMINATION OF GALLIUM WITH BUTYLRHODAMINE B. L. M. Skrebkova (Moscow State Univ.). Zhur. Anal. Khim., 16: 422-5 (July–Aug. 1961). (In Russian)

The formation of  $\text{GaCl}_4^-$  with butylrhodamine B and its extraction with toluene (benzene) were studied. This reaction is shown to be much more sensitive than the previously known reaction with rhodamine B. A method was developed for the photometric determination of gallium with butylrhodamine B in various gallium-containing materials. (auth)

**32131** AMPEROMETRIC TITRATION OF THORIUM SALTS WITH CUPFERRON. V. D. Vasilenko, E. B. Ostrovskaya, and T. S. Fomenko (Dnepropetrovsk State Univ., [USSR]). Zhur. Anal. Khim., 16: 433-7 (July–Aug., 1961). (In Russian)

Thorium forms with cupferron a precipitate of  $\text{ThCup}_4$  in a wide pH range in the absence of strong acids and sulfates. The precipitate has a tendency to form a colloid, and it is necessary to use coagulants; the most effective is sodium chloride. Sulfosalicylic acid is a stronger masking agent than citric acid during thorium titration in the presence of rare earths. The optimum conditions were established for the amperometric titration of thorium in the presence of cerium rare earths. The method was tested with artificial mixtures. The reproducibility and the accuracy of the method are satisfactory. (auth)

**32132** STUDY ON THE INTERACTION OF MOLYBDENUM (V) WITH ETHYLENE-DIAMINETETRA-ACETIC ACID. A. E. Klygin, N. S. Kolyada, and D. M. Zavrzhnova. Zhur. Anal. Khim., 16: 442-7 (July–Aug. 1961). (In Russian)

The molar extinction coefficient of  $\text{Mo(V)}$  with ethylene-diaminetetra-acetic acid  $(\text{MoO}_2)_2\text{H}_2\text{Y}$  is  $363 \pm 8$  at 387 m $\mu$ , and the complexing constant is  $(1.75 \pm 0.52) \times 10^{11}$ . A developed variant of the complexometric determination of  $\text{Mo(V)}$  is based on its complexing with complexone III and the titration of the complexone III excess with a zirconium sulfate solution in the presence of xlenol orange. (auth)

**32133** INVESTIGATIONS IN THE ANALYTICAL CHEMISTRY OF URANIUM. COMMUNICATION 3. PHOTOMETRIC DETERMINATION OF URANIUM IN ORES AND THE PRODUCTS OF THEIR TREATMENT BY MEANS OF ARSENAZO. V. F. Lukyanov, L. M. Moiseeva, and N. M. Kuznetsova. Zhur. Anal. Khim., 16: 448-51 (July–Aug., 1961). (In Russian)

A method was developed for the photometric determination of uranium in ores and concentrates using arsenazo I. Uranium is preliminarily separated from admixtures by the partition-chromatographic method, or by ion exchange on the CT-I cationite in the presence of complexone III. (auth)

**32134** DETERMINATION OF FREE NITRIC ACID IN URANYL NITRATE TRIBUTYL PHOSPHATE SOLU-

TIONS. V. M. Mikhailov. Zhur. Anal. Khim., 16: 458-61 (July–Aug. 1961). (In Russian)

A new method was worked out for the gravimetric and photometric determination of free nitric acid in tributyl phosphate solutions containing various quantities of uranyl nitrate. The composition of the compound, which is formed as a result of the reaction of nitric acid with acridine in tributyl phosphate solutions, corresponds to the formula  $\text{C}_6\text{H}_4 \cdot \text{CH} \cdot \text{C}_6\text{H}_4\text{N} \cdot \text{HNO}_3$ . (auth)

## General Inorganic and Physical Chemistry

**32135** (SRO-45) KINETICS OF THE REACTIONS INVOLVED IN THE FERRIC CHLORIDE ETCHING OF COPPER PHOTOENGRAVING PLATES. Final Report, April 1, 1959–March 31, 1961. W. H. Burrows, C. T. Lewis, Jr., and D. E. Saire (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). June 30, 1961. Contract AT(38-1)-202. 77p.

Experimental data show the heterogeneous reaction rate of copper with ferric chloride follows a second order polynomial dependency on the solution molarity for 25, 35, and 45°C at flow rates of 700 to 5500 ml/min. A slight fourth order dependence exists at 45°C. All trials exhibited maximum dissolution around 2.15 M ferric chloride. Temperature coefficients, Arrhenius activation energies, reaction rate, flow rate dependence, and sample position dependence of the reaction rate all support the proposition that the reaction is diffusion-controlled. Dissolved oxygen in the ferric chloride inhibits the reaction and is thought to be a surface poison. Viscosity and density data used with a derived equation show the reactivity of the species in increasing order to be  $\text{Fe}^{+3}$  and  $\text{FeOH}^{+2}$ ,  $\text{FeCl}_4^{+2}$ , and  $\text{FeCl}^{+2}$ .  $\text{FeCl}_3$  is not believed to be reactive. Inhibitor studies were conducted to investigate thiourea, ethylene thiourea, and formamidine disulfide. Several maxima and minima in the dissolution-rate-versus-inhibitor-concentration curve were observed with a rather sharp decrease in reaction rate occurring at  $2.5 \times 10^{-3}$  gram moles per liter of inhibitor. Temperature and flow rate effects on the inhibiting effects of formamidine disulfide were observed. (auth)

**32136** (AWRE/Trans-20) SPECTROPHOTOMETRIC DETERMINATION OF THE DISSOCIATION CONSTANTS OF SODIUM 1,8-DIOXY-2-(2'-OXYAZOBENZENE)-3,6-NAPHTHALENE DISULPHONATE. V. N. Tolmachev and G. G. Lomakina. Translated by F. E. Wallwork (U.K.A.E.A. Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.) from Zhur. Fiz. Khim., 31: 1027-32 (1957). 12p.

The absorption spectra have been studied of "metal indicators," 1,8-dioxy-2-(2'-oxyazobenzene)-3,6-naphthalene disulphonate [Acid Chrome Blue T]. With the aid of a spectrophotometric method the constants of the ternary dissociation of the dye are found to be  $K_1 = 2.8 \times 10^{-8}$ ,  $K_2 = 5.3 \times 10^{-10}$ , and  $K_3 = 4.0 \times 10^{-13}$ . (auth)

**32137** (AWRE/Trans-21) SPECTROPHOTOMETRIC STUDY OF THE REACTION BETWEEN SODIUM 1,8-DIOXY-2-(2'-OXYAZOBENZENE)-3,6-NAPHTHALENE DISULPHONATE AND MAGNESIUM IONS. V. N. Tolmachev and G. G. Lomakina. Translated by F. E. Wallwork (U.K.A.E.A. Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.) from Zhur. Fiz. Khim., 31: 1600-5 (1957). 13p.

The interaction between magnesium ions and sodium



1,8-dioxy-2-(2'-oxyazobenzene)-3,6-naphthalene disulphonate has been investigated with the aid of a spectrophotometric method. At pH 10 the complex  $MgR_2$  is formed, the instability constant of which is  $3.1 \times 10^{-9}$ . (auth)

**32138** (NP-tr-762) POLARIZATION OF THE ELECTRONIC BANDS OF AROMATIC COMPOUNDS. II. AZULENE. Herbert Zimmermann and Norman Joop. Translated by G. A. Crosby (Univ. of New Mexico, Albuquerque) from *Z. Elektrochem.*, 64: 1219-21(1960). 5p.

The relative polarization of the absorption bands of azulene was determined from the fluorescence polarization in solution and compared with theory. The polarization spectrum shows that, in addition to the known absorption bands, an additional electronic transition is present at about  $33900\text{ cm}^{-1}$ . The electronic transition was predicted on grounds of theoretical investigations. (auth)

**32139** STUDIES ON THE HYDROLYSIS OF METAL IONS. PART 36. AN ESTIMATES OF THE FORMATION CONSTANTS OF  $CaOH^+$ ,  $SrOH^+$  AND  $BaOH^+$  IN 3 M  $NaClO_4$ . Birgitta Carell, and Åke Olin (Royal Inst. of Tech., Stockholm). *Acta Chem. Scand.*, 15: 727-34(1961). (In English)

The formation constants of  $CaOH^+$ ,  $SrOH^+$ , and  $BaOH^+$  were estimated from measurements, at  $25^\circ\text{C}$ , of the emf,  $E$ , of the cells  $Pt/H_2$ , BM  $B^{2+}$ , (3-2B)M  $Na^+$ , AM  $OH^-$ , (3-A)M  $ClO_4^-$ /Ref (I) Ag, AgCl(AgBr)/BM  $B^{2+}$ , (3-2B)M  $Na^+$ , XM  $Cl^-(Br^-)$ , (3-X)M  $ClO_4^-$ /Ref (II) where  $B^{2+}$  stands for  $Ca^{2+}$ ,  $Sr^{2+}$ , or  $Ba^{2+}$  and the reference half-cell (Ref) was  $/3M\ NaClO_4/2.99M\ Na^+$ ,  $0.01M\ Ag^+$ ,  $3M\ ClO_4^-$ /Ag, AgCl. From the measured values of  $E$ ,  $[OH^-]$  was calculated using the relationship  $E = E^0 + 59.15\log[OH^-] - 9.3B - 8[OH^-]$ . The formation constants obtained for  $CaOH^+$ ,  $SrOH^+$ , and  $BaOH^+$  were  $0.642 \pm 0.015$ ,  $0.225 \pm 0.015$ , and  $0.004 \pm 0.015$ , respectively. (auth)

**32140** NEUTRON DIFFRACTION INVESTIGATION OF KCN. Norman Elliott and Julius Hastings (Brookhaven National Lab., Upton, N. Y.). *Acta Cryst.*, 14: 1018(Oct. 10, 1961). (In English)

Neutron diffraction measurements on KCN agree with the results calculated for a model containing freely rotating cyanide groups. They do not agree with the calculations made for a static model having  $CN^-$  groups randomly oriented along 111 directions. (auth)

**32141** CONTINUOUS SEPARATION OF GASEOUS MIXTURES BY THERMAL GRAVITATIONAL DIFFUSION. Harlan D. Frame, Jr., James R. Kuszewski, John F. Binder, and Harold H. Strain (Argonne National Lab., Ill.). *Anal. Chem.*, 33: 1741-5(Nov. 1961).

For the continuous separation of gases by thermal gravitational diffusion, a rectangular diffusion cell (internal dimensions,  $51 \times 51 \times 1\text{ cm}$ ) was constructed and tested. For the thermal gradient, one large wall was provided with a water jacket and cooled with tap water. The opposite large wall was heated against a specially wound, vertical electric furnace. Gas flow through the vertical diffusion chamber was horizontal. This arrangement provided three mutually transverse driving forces, thermal gradient, gravity, and gas flow. Separations were made in diffusion cells with a structure-free diffusion chamber, with a chamber containing loosely packed silica fibers (vertically aligned), and with a chamber containing porous stainless steel barriers (also vertically aligned). The structure-free cell produced the best helium-nitrogen separation, the cell with silica fibers the best nitrogen-argon separation, and the barrier cell the best neon isotope enrichment.

No significant dependence of the separations upon flow was found in any of the cells with flow rates from no flow to about 9% of the total internal volume per minute (150 ml per minute at room temperature). (auth)

**32142** COMBUSTION OF CARBON IN AN AIR STREAM. Jeffrey A. Moore and Martin Zlotnick (AVCO Research and Advanced Development Div., Wilmington, Mass.). *ARS (Am. Rocket Soc.) J.*, 31: 1388-97(Oct. 1961).

An investigation was made to determine the combustion rate of carbon operating at a surface temperature between 1000 and  $3000^\circ\text{K}$  in a stream of air. Relatively general forms of the surface reaction rate equations were used in the analysis, with the boundary layer equations simplified by letting  $Le_i = Pr = 1$ , so that the effect of the chemical kinetics could be elucidated. The results of the analysis can be used to make rapid estimates of mass loss rate for a wide range of free stream conditions. The accuracy of these estimates is limited primarily by the accuracy of the reaction rate parameters used rather than by the approximations used in the boundary layer equations, except when the combustion rate is controlled solely by diffusion and convection. Specific calculations, involving the graphical solution of two algebraic equations, were made at the stagnation point and a downstream station on a blunted slender body for a flight Mach number of 15 and an altitude of 100,000 ft. The ablation rate for porous carbon approached the diffusion (transport) controlled value at the stagnation point for nose radii greater than 1 cm. However, the rate of carbon removal was found to be governed only by the heterogeneous kinetics 16 cm downstream of the stagnation point (small bodies), and between the two limiting cases of reaction rate controlled and diffusion controlled at a distance of 400 cm downstream of the stagnation point (large bodies). The ablation rate for nonporous carbon, however, was reaction rate controlled for every station and geometry considered. (auth)

**32143** THE ACTINIDE ELEMENTS. Mario A. Rollier (Università, Pavia, Italy). *Chim., e ind. (Milan)*, 43: 775-81 (July 1961). (In Italian)

After a description of Ac and of the actinide elements most interesting from a commercial viewpoint, the electronic configuration of the actinides and the correlation of their properties with those of the lanthanides are discussed. The evolution of the acceptance of the actinides as a series homologous to the lanthanides is described. The "end" of the periodic system because of the increasing instability of elements with atomic number above 96 is also discussed. (tr-auth)

**32144** SECONDARY HYDROGEN ISOTOPES EFFECTS. III. ACETOLYSIS OF ENDO- AND EXO-NORBORNYL-5,6- $d_2$  p-BROMOBENZENESULFONATES. S. Borčić, V. Belanić-Lipovac, and D. E. Sunko (Institute "Ruder Bošković," Zagreb). *Croat. Chem. Acta*, 33: No. 1, 35-9(1961). (In English)

The synthesis of endo- and exo-norbornyl-5,6- $d_2$  p-bromobenzenesulfonates is described. The rate constants of the acetolysis were measured and an isotope effect was observed in the reaction of the exo-isomer. The result indicates that the 1,3-hydride shift occurs in the rate determining step. (auth)

**32145** FLUORESCENCE SPECTRA OF SOME URANYL SALTS. K. V. Narasimham (Madras Inst. of Tech., Chromepet, Madras). *Indian J. Phys.*, 35: 282-98(June 1961).

The fluorescence spectra of uranyl acetate, nitrate, sulfate, fluoride I, chloride, potassium uranyl sulfate, and

ammonium uranyl sulfate were reinvestigated at room and liquid air temperatures. New analyses were proposed for each spectrum on the basis of a single electronic allowed transition. (auth)

**32146** MASS SPECTROMETRIC STUDIES OF LOW PRESSURE PYROLYSIS REACTIONS OF CHLORINATED AND FLUORINATED  $C_1$  AND  $C_2$  COMPOUNDS ON GRAPHITE. Dino R. Bidinosti and Richard F. Porter (Cornell Univ., Ithaca, N. Y.). *J. Am. Chem. Soc.*, 83: 3737-43 (Sept. 20, 1961).

The pyrolysis behavior of chlorinated derivatives of methane, ethane, and ethylene was investigated in graphite ovens at pressures between  $10^{-2}$  and one mm of Hg in the temperature range 450–1300°K. Several  $C_2$  compounds studied transfer chlorine atoms from adjacent carbon atoms to the graphite surface. The pressure dependence of the yield of dechlorinated products indicated a first-order relationship between product and reactant. This is interpreted as evidence for the existence of an equilibrium reaction with graphite. Heats of reaction for the removal of two chlorine atoms from adjacent carbon atoms are found to vary between +12 and +25 kcal. The compound sym-tetrachloroethane pyrolyses to both sym-dichloroethylene and trichloroethylene, the latter by the elimination of HCl(g). The HCl elimination reactions are found to follow a more complex pressure dependence than those observed for dechlorination. Several fluoro-chloro  $C_1$  and  $C_2$  compounds also were dehalogenated over graphite. (auth)

**32147** CALCULATED ISOTOPE EFFECTS FOR REACTIONS OF LYONIUM ION IN MIXTURES OF LIGHT AND HEAVY WATER. C. Gardner Swain and Edward R. Thornton (Massachusetts Inst. of Tech., Cambridge). *J. Am. Chem. Soc.*, 83: 3884-9 (Sept. 20, 1961).

Relative nucleophilicities of  $D_2O$ , HDO, and  $H_2O$  are calculated. Equations relating isotope effect to atom fraction of deuterium in the solvent are derived for reactions of  $L_3O^+$  in water at 25° via  $SL^+$ ,  $S^-LO^+L_2$  or  $L_2O^+SL$ , and  $L_2O^+L-SL$  transition states, where L is H or D in any combination, S is any substrate and LS is any substrate with exchangeable L. Curves are shown for the three types for  $k_D/k_H$  values of 3, 2, 1, 0.73, and  $1/3$ . (auth)

**32148** CALCULATED ISOTOPE EFFECTS FOR REACTIONS OF LYOXIDE ION OR WATER IN MIXTURES OF LIGHT AND HEAVY WATER. C. Gardner Swain and Edward R. Thornton (Massachusetts Inst. of Tech., Cambridge). *J. Am. Chem. Soc.*, 83: 3890-6 (Sept. 20, 1961).

The nucleophilicity of  $DO^-$  relative to  $HO^-$  is calculated. Twelve equations relating isotope effect to atom fraction of deuterium in the solvent are derived for 21 extreme types of transition states for reactions of  $LO^-$  or  $L_2O$  in  $L_2O$  at 25°, where L is H or D in any combination, with various substrates S, LS, SX, and LSX without or with exchangeable L or displaceable halide ion X. Curves are shown for all of these equations for  $k_D/k_H$  values of 2, 1, and  $1/2$ . (auth)

**32149** ELECTROLYTIC GENERATION OF RADICAL IONS IN AQUEOUS SOLUTION. L. H. Piette, P. Ludwig, and R. N. Adams (Univ. of Kansas, Lawrence). *J. Am. Chem. Soc.*, 83: 3909-10 (Sept. 20, 1961).

The successful generation of both cation and anion radicals and especially negative ions from aliphatic nitro compounds in ordinary aqueous solutions is reported. The mono-negative ions of o-, m-, and p-nitroaniline, o-, m-, and p-nitrophenol, p-nitroanisole, p-nitrodimethylaniline, and nitrobenzene were generated and detected at a mercury pool electrode. The EPR spectra were all well resolved

and the hyperfine structure interpreted in terms of the molecular structure. It was observed that the radical ions decayed by a first order reaction (with a half life of about 2 sec) when the current was turned off. This suggests reaction with the solvent and not with another ion. The spectra of the mono-negative ions of aliphatic nitro compounds show a very strong  $N^{14}$  coupling and, also coupling of the unpaired electron with protons on the carbon adjacent to the nitrogen. (P.C.H.)

**32150** THE ELECTRONIC STRUCTURE OF URANIUM (IV) IN COMPLEX COMPOUNDS. I. COMPARISON OF THE ABSORPTION SPECTRA OF URANIUM (IV) AND PRASEODYMIUM (III) COMPOUNDS. B. Jezowska-Trzebiatowska and K. Bukietynska (Inst. of Physical Chemistry, Polish Academy of Science, Wroclaw). *J. Inorg. & Nuclear Chem.*, 19: 38-42 (Sept. 1961). (In English)

The absorption spectra of U(IV) in the organic solvents: methanol, tributylphosphate, acetylacetone, and tetrahydrofuran were investigated and compared with the isoelectronic praseodymium(III). The absorption bands of U(IV) correspond to the supposed  $5f^2$  electronic structure. A much stronger influence of the ligand's field on the  $5f^2$  levels than on the  $4f^2$  ones was observed. The Lande interval factor was accepted as quantitative measure, the value of which in the U(IV) depends on the type of solvent. (auth)

**32151** PREPARATION AND PROPERTIES OF SOME RARE EARTH BORATES. E. J. Felten (General Electric Co., Cincinnati). *J. Inorg. & Nuclear Chem.*, 19: 61-4 (Sept. 1961). (In English)

Rare earth borates of the  $ABO_3$  type were prepared by the reaction of the constituent oxides in equimolar ratios between 1200 and 1400° in air. The borates of yttrium and the smaller rare earth ions (samarium through lutetium) are isostructural with vaterite ( $\mu CaCO_3$ ). Melting points of the borates are greater than 1400° making them useful for applications at elevated temperatures. (auth)

**32152** THE DENSITY OF MOLTEN THORIUM AND URANIUM TETRAFLUORIDES. A. D. Kirshenbaum and J. A. Cahill (Temple Univ., Philadelphia). *J. Inorg. & Nuclear Chem.*, 19: 65-8 (Sept. 1961). (In English)

Using molybdenum crucibles and sinkers, the liquid densities of liquid uranium and thorium tetrafluorides were determined by the immersed-sinker method from 1300 to 1700°K and are represented by the equations  $D_{ThF_4}(l) = 7.108 - 7.590 \times 10^{-4}T$  and  $D_{UF_4}(l) = 7.784 - 9.920 \times 10^{-4}T$ . The liquid molar volumes and thermal coefficients of expansions were calculated from the liquid densities. (auth)

**32153** THE STRUCTURE OF URANYL AZIDE—ITS INSTABILITY CONSTANT IN AQUEOUS SOLUTIONS. F. G. Sherif and A. M. Awad (Univ. of Alexandria, Egypt). *J. Inorg. & Nuclear Chem.*, 19: 94-100 (Sept. 1961). (In English)

Aqueous solutions containing uranyl and azide ions were found to have a maximum absorption at the wavelength 420 mμ suitable for spectrophotometric studies. Spectrophotometric titrations in aqueous solutions and in water-acetone mixtures suggested the presence of complex ions containing uranyl and azide ions in the ratios 1:1 and 1:2 respectively. The slope ratio method and the continuous variation method confirmed the existence of the mono-azido uranyl complex ion  $[UO_2(N_3)]^+$ , the instability constant of which was found to be  $4.86 \pm 0.4 \times 10^{-3}$ . Conductimetric titrations indicated the possible stepwise formation of the mono-, di-



and triazido uranyl complex ions in relatively concentrated solutions. Migration experiments indicated the existence of both positively and negatively charged complex ions. (auth)

**32154** OXIDATION-REDUCTION POTENTIAL OF  $\text{UO}_2^{2+}$   $\text{U}^{4+}$  SYSTEM IN PERCHLORIC ACID. J. Sobkowski and S. Minc (Univ. of Warsaw). J. Inorg. & Nuclear Chem., 19: 101-6 (Sept. 1961). (In English)

The cell  $\text{Pt} | \text{UO}_2(\text{ClO}_4)_2, \text{U}(\text{ClO}_4)_4, \text{HClO}_4 || \text{HClO}_4, \text{H}_2 (\text{Pt})$ , in which the reaction  $\text{U}^{4+} + 2\text{H}_2\text{O} \rightleftharpoons \text{UO}_2^{2+} + 4\text{H}^+ + 2\text{e}^-$  takes place, was investigated. If the mobilities of  $\text{UO}_2^{2+}$  and  $\text{U}^{4+}$  at infinite dilution are assumed to be  $60 \pm 10 \Omega^{-1} \text{ cm}^2 \text{ eq}^{-1}$ ,  $E_D = +0.0017 \pm 0.0002 \text{ v}$ . Because  $E = 0.0017 \text{ v}$ , the standard oxidation-reduction potential of  $\text{UO}_2^{2+} - \text{U}^{4+}$  system is  $0.3273 \text{ v}$ , with an error not exceeding  $0.001 \text{ v}$ . Data are tabulated. Several previous works are referred to. (P.C.H.)

**32155** CATION-EXCHANGE ELUTION SEQUENCES. I. DIVALENT AND RARE-EARTH CATIONS WITH EDTA, HEDTA AND CITRATE. D. B. James, J. E. Powell, and F. H. Spedding (Ames Lab., Ames, Iowa). J. Inorg. & Nuclear Chem., 19: 133-41 (Sept. 1961). (IS-149). (In English)

Ion exchange elution sequences were established for some divalent and trivalent ions in elutions with those eluants commonly used for the separation of macroquantities of the rare-earth elements—ethylenediaminetetracetic acid (EDTA), hydroxyethylethylenediaminetriacetic acid (HEDTA), and citric acid. The order of elution of the sequence of trivalent metal ions was found to shift with respect to the sequence of divalent metal ions when the pH of the EDTA eluant was changed and as the composition of the separating mixture changed. A theory is presented which is of qualitative value as an aid in the description of the elution of polyvalent cation mixtures with chelating eluants. (auth)

**32156** THE INFRA-RED SPECTRA OF URANIUM SPECIES IN CARBON TETRACHLORIDE SOLUTIONS OF URANIUM (VI), DIBUTYL PHOSPHORIC ACID AND TRI-N-OCTYL PHOSPHINE OXIDE. J. Kennedy and A. M. Deane (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Inorg. & Nuclear Chem., 19: 142-55 (Sept. 1961). (AERE-R-3410) (In English)

Comparisons of the infrared spectra of uranyl dibutyl phosphate polymer  $[\text{UO}_2(\text{DBP})_2]_n$ , tri-n-octyl phosphine oxide (TOPO), and dibutyl phosphoric acid (HDBP), for both the separate reagents and in combination in carbon tetrachloride, are consistent with the formation of  $\text{UO}_2(\text{DBP})_2 \cdot 2\text{TOPO}$ ,  $\text{UO}_2(\text{DBP})_2\text{HDBP} \cdot \text{TOPO}$ , and  $\text{UO}_2(\text{DBP})_2 \cdot 2\text{HDBP}$ . The data imply that extraction of  $\text{UO}_2^{2+}$  from aqueous solutions by combinations of tri-n-octyl phosphine oxide and dibutyl phosphoric acid dimer may be represented by the equations  $\text{UO}_2^{2+} + 2(\text{HDBP})_2 + \text{TOPO} \rightleftharpoons \text{UO}_2(\text{DBP})_2 \cdot \text{HDBP} \cdot \text{TOPO} + \frac{1}{2}(\text{HDBP})_2 + 2\text{H}^+$  and  $\text{UO}_2^{2+} + (\text{HDBP})_2 + 2\text{TOPO} \rightleftharpoons \text{UO}_2(\text{DBP})_2 \cdot 2\text{TOPO} + 2\text{H}^+$ . Considerable hydrogen bonding between TOPO and HDBP occurs when these reagents are together in solution. The evidence for previously-postulated structural formulae for the uranium species is not conclusive, but the data are consistent with the equivalence of three DBP ligands in uranium species containing HDBP. (auth)

**32157** SOME EXPERIMENTS ON THE USE OF THE CHELATING ION EXCHANGER DOWEX A-1 IN NUCLEAR CHEMISTRY. R. Christell, S. Forberg, and T. Westermark (Royal Inst. of Tech., Stockholm). J. Inorg. & Nuclear Chem., 19: 187-9 (Sept. 1961). (In English)

Two preliminary experiments were performed to study the behavior of trivalent ions in the chelating ion exchanger Dowex A-1. The exchange between La and Cu in Cu-

saturated resins showed that the affinity of Dowex A-1 is slightly higher for  $\text{La}^{3+}$  than for  $\text{Cu}^{2+}$  under the conditions employed. The separation of  $\text{La}^{3+}$  and  $\text{Lu}^{3+}$  on a column of Ca-saturated resin indicated that Lu is eluted first. Data are tabulated. (P.C.H.)

**32158** THE EXCHANGE REACTION BETWEEN URANYL ION AND WATER IN PERCHLORIC ACID SOLUTION. G. Gordon and H. Taube (Univ. of Chicago). J. Inorg. & Nuclear Chem., 19: 189-91 (Sept. 1961). (In English)

The intrinsic exchange between uranyl ion and water is shown to proceed at a reasonable rate. Data for the series were treated analytically to compute the reported half lives, and values for the rate of exchange for each experiment were calculated. The dominant path for the exchange of  $\text{UO}_2^{2+}$  with water presumably takes place through the ion  $\text{UO}_2\text{OH}^+$ . (P.C.H.)

**32159** RATE OF THE REACTION  $\text{NO} + \text{N} \rightarrow \text{N}_2 + \text{O}$  AND SOME HETEROGENEOUS REACTIONS OBSERVED IN THE ION SOURCE OF A MASS SPECTROMETER. John T. Herron. J. Research Natl. Bur. Standards, 65A: 411-13 (Sept.-Oct. 1961).

The rate of the reaction  $\text{NO} + \text{N} \rightarrow \text{N}_2 + \text{O}$  was measured to be  $1.0 \pm 0.5 \times 10^{13} \text{ cm}^3 \text{ moles}^{-1} \text{ sec}^{-1}$  at room temperature. The heterogeneous reactions  $\text{N} + \text{O} \rightarrow \text{NO}$  and  $\text{O} + \text{O} \rightarrow \text{O}_2$  were observed to occur in the ion source of the mass spectrometer. (auth)

**32160** TRITIUM-LABELED COMPOUNDS VII. ISOTOPE EFFECTS IN THE OXIDATION OF D-MANNITOLS- $\text{C}^{14}$  AND D-MANNITOLS-t TO D-FRUCTOSES. Lorna T. Sniegowski, Harriet L. Frush, and Horace S. Isbell. J. Research Natl. Bur. Standards, 65A: 441-9 (Sept.-Oct. 1961).

D-Mannitols, labeled either with carbon-14 at C1, C2, or C3, or with tritium attached to C1, C2, or C3, were prepared. After oxidation by *Acetobacter suboxydans*, the distribution of radioactivity in each of the resulting labeled D-fructoses was determined. Labeled D-mannitol is unique among the hexitols in that it may be oxidized by *A. suboxydans* in either the labeled or the unlabeled part of the molecule. Except in the oxidation of D-mannitol-2-t, the competing reactions result in the formation of a mixture of D-fructoses, each having radioactivity in one of two different positions. Hence, the isotope effect,  $k^*/k$ , (where  $k^*$  and  $k$  are, respectively, the rate constants for oxidation in the labeled and in the unlabeled part of the labeled D-mannitol molecule) is the ratio of the activities at the two positions of the product, D-fructose. The following isotope effects were found for the bacterial oxidation of labeled D-mannitols: for D-mannitol-2- $\text{C}^{14}$ ,  $k^*/k = 0.93$ ; for D-mannitol-2-t,  $k^*/k = 0.23$ ; and for D-mannitol-3-t,  $k^*/k = 0.70$ . For D-mannitols labeled at other positions, no isotope effect was detected, since  $k^*/k$  was unity. The large isotope effect for D-mannitol-2-t is indicative of rupture of the C2-H bond in the rate determining process. It is suggested that the secondary isotope effect for tritium at C3 indicates hyperconjugation of the C3 hydrogen atom in the activated enzyme—substrate complex; the lack of such effect for tritium at C1 may be due to unfavorable steric conditions for hyperconjugation of the C1 hydrogen atoms in the complex. The following substances were prepared and their isotopic distributions determined: D-fructose-1,6- $\text{C}^{14}$  and D-fructose-1,6-t (from 1-labeled D-mannitols); D-fructose-2,5- $\text{C}^{14}$  and D-fructose-5-t (from 2-labeled D-mannitols); and D-fructose-3,4- $\text{C}^{14}$  and D-fructose-3,4-t (from 3-labeled D-mannitols). A procedure, employing D-fructose-1,6- $\text{C}^{14}$  as an internal standard, was devised for the analysis of D-fructose-3,4-t. (auth)

**32161 THE SOLUBILITY OF KRYPTON IN LIQUID CADMIUM AND INDIUM.** G. W. Johnson (Univ. of Leeds, Eng.). *Phil. Mag.* (8), 6: 943-6 (July 1961).

Experimental measurements of the solubility of krypton in divalent cadmium and trivalent indium were made. Values obtained compared favorably with those estimated from the surface energies of these elements. (L.N.N.)

**32162 PHOTO-IMPEDANCE OF THE AgCl ELECTRODE SYSTEM.** D. A. Wiegand (Cornell Univ., Ithaca, N. Y.) and Carnegie Inst. of Tech., Pittsburgh). *Phys. Rev.*, 124: 104-14 (Oct. 1, 1961).

The observed frequency response of the AgCl-electrode system indicates an equivalent parallel combination of capacitance and conductance in series with the bulk photo-conductance. The voltage dependence of the capacitance suggests an exhaustion layer, presumably at the sample-electrode interface, and the magnitude of the capacitance indicates that the layer is thick. Qualitatively, the dependence of the layer capacitance and current on the intensity and wavelength of the exciting illumination, on temperature, and on voltage can then be understood in terms of a potential barrier. Alternatively, the results can be described in terms of layers, presumably at the surface, of lower conductivity than the bulk. An increase of the capacitance with the bulk conductivity, and so with the density of mobile electrons, suggests that the positive charge in the exhaustion region is determined at least in part by holes generated by illumination. The dependence of the bulk photoconductivity on temperature, voltage, intensity, and wavelength are discussed. (auth)

**32163 CO-CRYSTALLIZATION OF PROTACTINIUM WITH COMPLEX COMPOUNDS OF TI, Nb, AND Ta.** A. V. Lapitskii and Ya-wu Chuang. *Radiokhimiya*, 3: 241-5 (1961). (In Russian)

The distribution of  $\text{Pa}^{233}$  between solid and liquid phases of Nb, Ta, and Ti complexes with Schiff's reagent base at 20° shows that D and  $\lambda$  are constant for niobium and tantalum salicylaethylenediamine solutions. The latter attests to the presence of isomorphous distribution. Properties of protactinium salicylaethylenediamine are analyzed. (R.V.J.)

**32164 ION EXCHANGE OF ELEMENT GROUPS. VII. ELEMENTS OF THE FIFTH ANALYTICAL GROUP (ARSENIC GROUP).** B. K. Preobrazhenskii and L. N. Moskvina. *Radiokhimiya*, 3: 309-15 (1961). (In Russian)

Ion exchange separations of group V elements (As, Se, Ge, Te, Sb, Sn, Mo, Re, and Au), which can be applied for isotope separation in complex mixtures and for analytical purposes, were investigated. (R.V.J.)

**32165 SOLUBILITY OF PEROXIDE COMPLEXES OF URANYL ION.**  $\text{K}_4[\text{UO}_2(\text{O}_2)_3] \cdot 5\text{H}_2\text{O}$  AND  $\text{K}_4[\text{UO}_2(\text{O}_2)_3] \cdot 4\text{H}_2\text{O} \cdot 4\text{H}_2\text{O}$ . A. M. Gurevich and L. P. Polozhenskaya. *Radiokhimiya*, 3: 316-20 (1961). (In Russian)

The exceptionally high water solubility of  $\text{K}_4[\text{UO}_2(\text{O}_2)_3] \cdot 5\text{H}_2\text{O}$ , equal to  $1.7 \pm 0.1$  mol/l at 0°C, which rapidly drops to  $1.6 \times 10^{-3}$  mol/l with increased KOH concentration was analyzed. The results indicate a considerable tendency of  $\text{K}_4[\text{UO}_2(\text{O}_2)_3] \cdot 5\text{H}_2\text{O}$  to hydrolyze and decompose. A simple method is suggested for preparing the salt by depressing the solubility with concentrated KOH solution. The solubility of  $\text{K}_4[\text{UO}_2(\text{O}_2)_3] \cdot 4\text{H}_2\text{O} \cdot 4\text{H}_2\text{O}$  at 0°C in water was 0.121 mol/l. It is shown that hydrogen peroxide splitting and  $\text{K}_4[\text{UO}_2(\text{O}_2)_3] \cdot 5\text{H}_2\text{O}$  formation take place during the interaction of solid phase  $\text{K}_4[\text{UO}_2(\text{O}_2)_3] \cdot 4\text{H}_2\text{O} \cdot 4\text{H}_2\text{O}$  with KOH. (R.V.J.)

**32166 COMPLEX NATURE OF URANIUM PEROXIDES.** A. M. Gurevich. *Radiokhimiya*, 3: 321-38 (1961). (In Russian)

It is shown that uranium peroxide compounds are typical uranyl complexes that include peroxide, hydroperoxide, hydroxide, and aquo-groups. Hydrolysis and decomposition mechanisms in peroxide saturated uranyl triperoxide,  $[\text{UO}_2(\text{O}_2)_3]^{4-}$ , were studied, and it is shown that the important steps in the process result in the production of kinetically unstable complexes containing hydroperoxide groups and in conversion of these compounds into stable dimers in which the uranyl ions are bridge bonded by peroxide. It is also shown that in the transition from peroxide complexes  $\text{R}_4[\text{UO}_2(\text{O}_2)_3] \cdot \text{H}_2\text{O}$  and  $\text{R}_6[(\text{UO}_2)_2(\text{O}_2)_5(\text{H}_2\text{O})_2] \cdot \text{H}_2\text{O}$  to the aquohydroxy peroxide type  $\text{R}_4[(\text{UO}_2)_2(\text{O}_2)_3(\text{OH})_2(\text{H}_2\text{O})_4] \cdot \text{H}_2\text{O}$  and  $\text{R}_2[(\text{UO}_2)_2(\text{O}_2)_2(\text{OH})_2(\text{H}_2\text{O})_6] \cdot \text{H}_2\text{O}$ , the solubility value drops and the stability sharply increases. The uranyl coordination number in most cases remains 6. The high bond stability of peroxide groups with uranyl ions in various genetic series of peroxide complexes is confirmed. (R.V.J.)

**32167 KINETICS OF U(IV) OXIDATION BY CHLORITE IN ACID SOLUTIONS.** E. A. Kanevskii and L. A. Fedorova. *Radiokhimiya*, 3: 339-47 (1961). (In Russian)

The kinetics of U(IV) oxidation in perchloric and sulfuric acids containing chlorite was studied, and it is shown that chlorite does not act as a direct oxidizer. Introduced into acid solution, it disintegrates into fast- and slow-acting components. The total oxidation equivalent of chlorite in relation to U(IV) is 2. The analysis of  $\text{HClO}_2$  participation in disproportionation and chlorine dioxide formation reactions shows that the above magnitude is linearly dependent on hydrogen ion concentration. The dependence of the percentage of U(IV) oxidized by the fast-acting component on initial chlorite concentration was established. (R.V.J.)

**32168 KINETICS OF RADIOACTIVE ELEMENT LEACHING FROM MINERALS.** K. F. Lazarev. *Radiokhimiya*, 3: 359-64 (1961). (In Russian)

Studies were made of the time rate of hydrochloric and sulfuric acid leaching of  $\text{Ra}^{224}$ ,  $\text{U}$ ,  $\text{Th}^{228}$ ,  $\text{Th}^{234}$ ,  $\text{Th}$ , and rare earths from monazite and viikite specimens. (R.V.J.)

**32169 CO-PRECIPITATION OF Ce AND La POTASSIUM SULFATE.** V. I. Grebenshchikov and V. N. Bobrova. *Radiokhimiya*, 3: 377-83 (1961). (In Russian)

The recrystallization of potassium sulfate precipitate decreases following Ce and La adsorption. The relation between Ce and La crystallization coefficients in  $\text{Me}^{3+} - \text{K}_2\text{SO}_4 - 0.5 \text{N HNO}_3$  and the solubility of the separated binary salts were established. The participation of Ce and La in potassium sulfate crystals as binary salts  $\text{K}_5\text{La}(\text{SO}_4)_4$  and  $\text{K}_5\text{Ce}(\text{SO}_4)_4$  was confirmed. (R.V.J.)

**32170 COPRECIPITATION OF YTTRIUM, ZIRCONIUM, AND BARIUM WITH POTASSIUM SULFATE.** V. I. Grebenshchikova and V. N. Bobrova. *Radiokhimiya*, 3: 384-90 (1961). (In Russian)

Studies of Zr, Ba, and Y distribution between potassium sulfate crystals and solution indicate the absence of a lower limit of miscibility during the formation of anomalous mixed crystals in  $\text{K}_2\text{SO}_4 - \text{Zr} - 0.5 \text{N HNO}_3$ . It is also shown that yttrium adsorbed on potassium sulfate crystals does not influence the recrystallization rate of the precipitate. The relation between yttrium and zirconium distribution coefficients and the solubility of their binary salts confirms mixed crystal formation by co-crystallization of potassium sulfate with microcomponent binary sulfate salts. (R.V.J.)

**32171 DETERMINATION OF THE COMPOSITION AND INSTABILITY CONSTANTS OF Am(III) AND Cm(III) LAC-**



TATE COMPLEXES BY ION EXCHANGE. I. A. Lebedev and G. N. Yakovlev. *Radiokhimiya*, 3: 455-7 (1961). (In Russian)

Sorption of Am(III) and Cm(III) on cation resin KU-2 as a function of lactate ion concentrate was studied. The results show the presence of  $\text{AmLact}^{2+}$ ,  $\text{Am}(\text{Lact})_2^+$ ,  $\text{CmLact}^{2+}$  and  $\text{Cm}(\text{Lact})_2^+$ . Instability constants were calculated. (R.V.J.)

**32172 KINETICS OF IODIDE HYDROGEN PEROXIDE OXIDATION REACTION IN PRESENCE OF THORIUM SALTS.** K. B. Yatsimirskii and Yu. A. Zhukov. *Radiokhimiya*, 3: 466-72 (1961). (In Russian)

A kinetic equation was developed for iodide oxidation by hydrogen peroxide in the presence of thorium salts. A maximum catalytic activity is found with  $\text{ThOH}^{3+}$ . The thorium hydrolysis constants are calculated on the basis of the catalytic reaction rate. (R.V.J.)

**32173 ON THE COMPOSITION AND SOLUBILITY OF LANTHANUM AND YTTRIUM OXALATES.** R. V. Bryzgalova and I. V. Chernitskaya. *Radiokhimiya*, 3: 478-85 (1961). (In Russian)

Preparations of lanthanum and yttrium oxalates in mixed nitric and oxalic acid solutions or in ammonium oxalate at 20°C are described. Normal oxalates,  $\text{La}_2(\text{C}_2\text{O}_4)_3 \cdot 9\text{H}_2\text{O}$  and  $\text{Y}_2(\text{C}_2\text{O}_4)_3 \cdot 9\text{H}_2\text{O}$ , are precipitated from  $\text{HNO}_3$  (0.1, 0.5, and 1.5*N*) saturated with oxalic acid (0.1 to 0.9*M*). Salts from mixed nitric acid and ammonium oxalate precipitated depending on the acidity and the concentration of oxalate ions. For La salts,  $(\text{La}^{3+}/\text{C}_2\text{O}_4^{2-}) = 1.05$  or 0.79, which corresponds to  $\text{La}_2(\text{C}_2\text{O}_4)_3 \cdot 9\text{H}_2\text{O}$  and  $\text{NH}_4[\text{La}(\text{C}_2\text{O}_4)_2] \cdot 3\text{H}_2\text{O}$ . For Y salts,  $(\text{Y}^{3+}/\text{C}_2\text{O}_4^{2-}) = 0.67$  or 0.5, which corresponds to  $\text{Y}_2(\text{C}_2\text{O}_4)_3 \cdot 9\text{H}_2\text{O}$  and  $\text{NH}_4[\text{Y}(\text{C}_2\text{O}_4)_2] \cdot \text{H}_2\text{O}$ . The solubilities of lanthanum and yttrium oxalates in mixed nitric and oxalic acid and in nitric acid and ammonium oxalate were determined. (R.V.J.)

**32174 ON THE COMPOSITION AND SOLUBILITY OF LANTHANUM OXALATES IN VARIOUS SOLUTIONS.** V. I. Grebenshchikova, R. V. Bryzgalova, and I. V. Chernitskaya. *Radiokhimiya*, 3: 486-9 (1961). (In Russian)

A normal lanthanum oxalate,  $\text{La}_2(\text{C}_2\text{O}_4)_3 \cdot 8\text{H}_2\text{O}$ , is precipitated from mixed nitric and oxalic acid at 50°C. The solubility of lanthanum oxalate at 50°C is found for various solutions. It is shown that increasing oxalic acid concentration from 0.1 to 0.9*M* reduces the solubility of  $\text{La}_2(\text{C}_2\text{O}_4)_3 \cdot 8\text{H}_2\text{O}$  from  $5 \times 10^{-3}$  to  $1.7 \times 10^{-4}$  *M*. Complex  $\text{La}^{3+}$  oxalate ions are formed in nitric and oxalic acid solutions. (R.V.J.)

**32175 RATE AND MECHANISM OF THE THERMAL IONIZATION OF XENON.** Harold S. Johnston and Wade Kornegay (Univ. of California, Berkeley). *Trans. Faraday Soc.*, 57: 1563-77 (Sept. 1961).

The rate of the chemical reaction  $\text{Xe} \rightarrow \text{Xe}^+ + e^-$  between 4200-7600°K was followed by microwave absorption in a shock tube. Results are explained in terms of the mechanism:  $\text{M} + \text{Xe} \xrightarrow{b} \text{M} + \text{Xe}^* \xrightarrow{c} \text{M} + \text{Xe}^+ + e^-$ . The complex rates are resolved into two empirical rate constants,  $k_1$  and  $k_2$ . From the observed activation energies it is concluded that  $b \ll c$ , and in this case the empirical  $k_1$  is  $a$  and the empirical  $k_2$  is  $c$ . The activation energies are:  $E_1 = 8.4 \pm 1$  eV, and  $E_2 = 3.7 \pm 1$  eV (the ionization potential of xenon is 12.1 eV), and the cross-section for the second process is about  $10^3$  times that for the first. By virtue of imprisonment of resonance radiation, the quantum of energy represented by  $\text{Xe}^*$  is held in the system for a large number of collisions. (auth)

**32176 DETERMINATION OF THE ENTHALPY AND HEAT CAPACITY OF BORON OXIDE  $\text{B}_2\text{O}_3$  FROM 1000 TO 2200°K.** R. M. Krasovitskaya, P. B. Kantor, L. S. Kan, V. V. Kandyba, L. M. Kutsyna, and E. N. Fomitchev (Inst. of Standards and Measuring Instruments, USSR). *Zhur. Fiz. Khim.*, 35: 1499-1501 (July 1961). (In Russian)

The results of enthalpy measurements on  $\text{B}_2\text{O}_3$  in the liquid state are described. Measurements were carried out in a high temperature vacuum container of a massive isothermal calorimeter. The temperature of the container was measured with the aid of high-precision optical pyrometer EOP-51 with an accuracy of  $\pm 2^\circ$  up to 2000°K. From the experimental data equations were derived for the enthalpy and heat capacity of boron oxide. The values are in agreement with those of other authors to 1%. (auth)

**32177 ELECTROCHEMICAL BEHAVIOR OF NICKEL IN SULFURIC ACID IN THE PRESENCE OF VARIOUS OXIDANTS.** N. Ya. Bune and Ya. M. Kolotyrkin (Karpov Inst. of Physics and Chemistry, USSR). *Zhur. Fiz. Khim.*, 35: 1543-50 (July 1961). (In Russian)

A study was made of the dependence of dissolution velocity and of the electrodic potential of nickel on the concentration of various oxidants ( $\text{Fe}^{3+}$ ,  $\text{Ce}^{4+}$ ,  $\text{MnO}_4$ ,  $\text{Cr}_2\text{O}_7$ ,  $\text{H}_2\text{O}_2$ ) in 1.0 *N*  $\text{H}_2\text{SO}_4$ . A critical oxidant concentration was found to exist, below which nickel remains active and its dissolution velocity increases linearly with increased oxidant content. When the critical concentration is surpassed the nickel surface becomes passive, as manifested in a considerable drop in the dissolution rate of nickel. The experimentally observed relation between the dissolution rate of nickel and the concentration and nature of the oxidant was shown to be due to the existence of a corresponding relation for the electrode potential. The dissolution rate has a given value for each given value of the electrode potential, no matter whether the latter results from addition of oxidant to the solution or from polarization of the metal by external current. It was concluded that the oxidants investigated do not participate directly in the formation of the passivating layer and that passivation of the nickel is the result of chemisorptional interaction between surface atoms of the metal and the oxygen of water. The part played by the oxidant is its depolarizing effect on the electrode and its effect on the electrode potential. It is shown that the efficiency of the inhibiting action of varying species of oxidants depends upon their electrochemical characteristics, in particular, upon the magnitude of the corresponding redox potential and exchange current as well as upon the nature of the relation between the rate of reduction of the oxidizing component and the electrode potential of the metal. (auth)

**32178 OSCILLOGRAPHIC POLAROGRAPHY. KINETICS OF CATHODIC AND ANODIC POLARIZATION FOR  $\text{UO}_2^{2+}$  IN  $\text{HClO}_4$  SOLUTION.** Ya. P. Gokhstein and Ts'ai-sheng Kao (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR). *Zhur. Fiz. Khim.*, 35: 1611-15 (July 1961). (In Russian)

The cathodic and anodic processes of the first uranium wave in 0.05*N*  $\text{HClO}_4$  + 0.45*N*  $\text{NaClO}_4$  are shown to be irreversible. Also irreversible is the second stage of  $\text{UO}_2^{2+}$  reduction. The second anodic peak corresponds to oxidation of  $\text{UO}^+$  to  $\text{UO}^{2+}$ . Rate constants and free energies of activation were calculated for both stages of the two-step electrodic process. (auth)

**32179 A REVIEW OF RESEARCH IN FUSED SALT ELECTROCHEMISTRY FOR THE YEAR OF 1960.** A. G. Morachevskii. *Zhur. Priklad. Khim.*, 34: 1398-1411 (June 1961). (In Russian)

Research on fused salt electrochemistry is reviewed. 311 references. (R.V.J.)

**32180** LIQUID HYDROCARBONS AND THEIR APPLICATIONS. (to Fluitherma (Chauffage Industriel à Haute Température)). French Patent 1,234,835. May 23, 1960.

The application of lower alkyl derivatives of the terphenyls as heat transfer agents, reactor moderators, hydraulic fluids, and lubricants is proposed. The preferred product is obtained by alkylating 1 part terphenyl with 3 parts  $C_2H_5Br$  at  $15^\circ C$  in the presence of 3 to 4 parts  $AlCl_3$  as the catalyst, and recovering the fraction that boils above  $180^\circ C$  at 0.4 mm Hg. (NPO)

## Radiation Chemistry and Radiochemistry

**32181** (AERE-C/M-345) THE PRODUCTION OF CHEMICALS FROM REACTORS. PART II. DEPOSITION OF ENERGY BY FISSION FRAGMENTS IN TWO-PHASE SYSTEMS. G. Long (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Nov. 1958. 12p.

The fraction (F) of the total fission fragment energy deposited outside a slab and a sphere in which fission is occurring uniformly was calculated, assuming a square-law energy-range relationship for the fission fragments. The validity of this assumption is discussed. (auth)

**32182** (AERE-C/R-2710) THE PRODUCTION OF CHEMICALS FROM REACTORS. PART I. THE FIXATION OF ATMOSPHERIC NITROGEN BY FISSION FRAGMENTS. C. G. Edwards and F. Moseley (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Oct. 1958. 34p.

Sealed silica tubes containing air and other nitrogen-oxygen mixtures were irradiated in BEPO. The gases were subjected to direct bombardment by fission fragments from a thin film of  $U_3^{235}O_8$  deposited on the inside of platinum cylinders contained inside the tubes. In this way the G values for the fixation of nitrogen as oxides of nitrogen under fission fragment irradiation were investigated in the pressure region from 0 to 1 atmosphere. G for the total fixation was found to increase with increasing oxygen-nitrogen ratio, with the addition of water vapor and slightly with increasing pressure. For dry air at atmosphere pressure it is  $\sim 0.9$  averaged along the whole fission fragment track. A variation in the efficiency of energy utilization for fixation purposes was observed to occur along the length of the fragment track. The relevance of the results to possible designs of chemical producing reactor is discussed. (auth)

**32183** (AERE-R-2913) THE PRODUCTION OF CHEMICALS FROM REACTORS. PART III. THE IRRADIATION OF CARBON MONOXIDE-HYDROGEN GAS MONOXIDE-HYDROGEN GAS MIXTURES WITH FISSION FRAGMENTS FROM THIN FILMS OF  $U_3^{235}O_8$ . F. Moseley, A. E. Truswell, and C. G. Edwards (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Apr. 1959. 24p.

Sealed silica tubes containing mixtures of hydrogen and carbon monoxide in varying proportions were irradiated in BEPO. The gases were subjected to direct bombardment by fission fragments from a thin film of  $U_3^{235}O_8$  deposited on the inside of platinum cylinders contained inside the tubes. Small amounts of carbon dioxide, methane, and formaldehyde were detected in the product. The yield of carbon

dioxide is shown to be dependent on the amount of fission fragment energy deposited in the gas phase and on the initial partial pressure of carbon monoxide. The yields of methane and formaldehyde appear to be dependent on the ratio of  $CO:H_2$  in the gas mixture, but are too low to allow firm conclusions to be drawn. (auth)

**32184** (CK-2240(Del.)) SURVEY OF THE CHEMISTRY OF PLUTONIUM. L. I. Katzin (Chicago. Univ. Metallurgical Lab.). Oct. 1, 1944. Decl. with deletions Dec. 1, 1960. 46p.

Information is presented in a survey based on work which was started with trace scale experiments and extended by experiments with ponderable amounts of material. Included are sections on Pu nuclear-physical properties, fundamental chemistry of Pu, and separation processes. (J.R.D.)

**32185** (NYO-9421) A COMPARISON OF RADIATION-INDUCED GRAFT COPOLYMERIZATION UTILIZING ELECTRON ACCELERATORS AND ISOTOPE SOURCES AS RADIATION INITIATORS. Quarterly Summary Report, July 18 to October 17, 1961. [George Odian, William F. Oliver, and Earl Pierre] (Radiation Applications Inc., Long Island City, N. Y.). Oct. 17, 1961. Contract AT(30-1)-2636. 5p.

A brief examination of the post-irradiation grafting of machine-irradiated polyethylene film with acrylic acid monomer was made. Evidence of postgrafting was detected in samples that were irradiated to a total dose of 10 Mrads at a dose rate of 0.01 Mrad/sec and then exposed to a 25% purified acrylic acid solution in benzene for periods of 1 to 4 days. (auth)

**32186** (ORNL-3176(p.1-11)) NUCLEAR CHEMISTRY. J. Halperin, J. H. Oliver, et. al. (Oak Ridge National Lab., Tenn.).

Upper limits were measured for the thermal-neutron-capture cross sections of  $Po^{210}$  to form the isomers 0.52-sec  $Po^{211}$  and 27-sec  $Po^{211}$  as 30 and 0.5 mb respectively. The low cross section of  $Po^{210}$  can be understood on the basis of the closed shell of 126 neutrons and the energetics and spin states of the system. By irradiating samples of  $U^{233}$  with neutrons and measuring the  $U^{234}$  formed mass-spectrographically, the thermal cross section and resonance integral for capture were measured directly. Together with the resonance integral for fission, a value of  $\alpha$  for epithermal neutrons is reported as  $\alpha_{epi}(U^{233}) = 0.170$ . A program was written for the IBM 7090 computer to calculate the reaction rate and effective cutoff energy  $E_c$  for a  $1/\nu$  absorber inside a spherical, cylindrical, or double-slab filter containing boron, cadmium, gadolinium, or samarium. Results to date indicate that effective cadmium cutoffs are very nearly independent of the lower limit of the  $1/E$  flux; that gadolinium filters afford lower cutoffs but are less efficient than cadmium filters. The thermal-neutron-capture cross section and capture resonance integral of  $Ce^{144}$  were found to be  $0.96 \pm 0.1$  and  $2.6 \pm 0.2$  barns. The nuclide  $Re^{184}$  was shown to have a long-lived isomeric state and to decay with half lives of  $33 \pm 4$  and  $169 \pm 9$  days. A decay scheme is proposed, based primarily on single-crystal and coincidence measurements with NaI spectrometers. New light was shed on the level structure of  $Ge^{74}$  by studying the radiations of  $As^{74}$  using single-crystal and coincidence scintillation spectrometry. A new half life of  $17.74 \pm 0.05$  days was obtained for  $As^{74}$ . Rapid radiochemical separations of Zr, Nb, and Mo from thermal-neutron-irradiated solutions of  $U^{235}$  gave evidence for a previously unreported  $\sim 10$ -sec activity, which is a precursor of fission product  $Mo^{99}$  and is probably due to an isomer of  $Nb^{99}$ . If this is true, the data obtained indicate a fractional cumulative yield of  $0.96 \pm 0.21$  for  $Nb^{99}$ .



and imply that a suggested effect of the 50-proton shell on fission-yield distributions may not be great. The ranges of 2.736-Mev tritons produced by the reaction  $\text{Li}^6(n,\alpha)\text{H}^3$  were measured in xenon, krypton, nickel, argon, aluminum, air, nitrogen, and polystyrene. Values of range and energy loss were obtained for triton energies up to 2.7 Mev. The conceptual design of a "three-dimensional" pulse-height analyzer for storing information from coincidence experiments is described. A ferrite core memory with 20,000 channels, with a storage capacity of  $(10^6 - 1)$  counts per channel, is arranged into a basic  $200 \times 100$  channel sorting and storage array. The precision attained in beta polarization measurements was increased as a result of alterations in experimental equipment. The longitudinal polarization of  $\text{P}^{32}$  beta rays at 615.6 kev was found to be  $(98.8 \pm 0.9)\%$  of the theoretical value,  $-v/c$ . (auth)

**32187** (ORNL-3176(p.26-38)) RADIATION CHEMISTRY. H. W. Kohn, G. E. Moore, et. al. (Oak Ridge National Lab., Tenn.).

Radiation yields from deuterated silica gel exchange with methane and with hydrogen were determined as a function of gel pretreatments, reaction temperature, and purity. The results suggest a charge-transfer mechanism initiated by ions formed in the gel. Thermoluminescence studies were initiated. Rates and activation energies for hydrogen-deuterium exchange and formic acid decomposition were measured on a series of doped germanium catalysts covering the range from highly p- to highly n-type. The radiolytic stability of the alkali-metal bromates toward  $\text{Co}^{60}$  gamma rays was found to decrease from  $\text{LiBrO}_3$  to  $\text{CsBrO}_3$ , to increase only slightly with temperature between  $-195$  and  $85^\circ\text{C}$ , and, for  $\text{CsBrO}_3$ , to be almost independent of the dose rate for a change in this variable of nearly two orders of magnitude. The initial 100-ev yields for the decomposition of bromate ion appeared to increase exponentially with the "free space" in the crystal. Bromite, hypobromite, bromide, and oxygen gas were formed as radiolytic products. Almost all the oxidation states higher than bromide could be removed by thermal annealing. Yields were measured for decomposition of various nitrate crystals by 3.4-Mev alpha particles, cobalt gamma rays, and ultraviolet light at several temperatures. The fact that the increase in yield with increase in stopping power (alpha particles compared with gamma rays or ultraviolet light) roughly parallels the increase in yield with increased temperature (for decomposition by gamma rays or ultraviolet light) suggested that thermal effects along alpha-particle tracks are an important factor in the radiolysis. The study of the radiolysis by transferred energy of substances suspended in alkali halides was continued, with special attention to the decompositions of  $\text{NO}_3^-$  and  $\text{NO}_2^-$  in potassium bromide. No equilibrium is attained between  $\text{NO}_3^-$  and its radiolysis products; the nitrite ion found in an aqueous solution of irradiated  $\text{KNO}_3$  exists in the solid prior to dissolution and does not arise by reaction of stabilized intermediates with water. The solubilities of  $\text{KNO}_3$  and  $\text{KNO}_2$  in  $\text{KBr}$  (0.21 and 0.082 mole % respectively) were determined by a new method. The kinetics of the decompositions of  $\text{NO}_3^-$  and  $\text{NO}_2^-$  in  $\text{KBr}$  are being studied. From a study of the  $\text{G}(\text{H}_2)$ ,  $\text{G}(\text{O}_2)$ ,  $\text{G}(\text{Ce}^{3+})$ , and  $\text{G}(\text{Ce}^{3+})_{\text{T}1+}$  from  $\text{Co}^{60}$  gamma-irradiated concentrated aqueous  $\text{HNO}_3$  and  $\text{Ce}^{4+}$ -0.4 M  $\text{H}_2\text{SO}_4$ - $\text{HNO}_3$  solutions and a comparison of these yields with those determined in comparable  $\text{NaNO}_3$  solutions, it may be concluded that  $\text{HNO}_3$  decomposes by two mechanisms: a molecular process  $\text{HNO}_3 \rightarrow \text{HNO}_2 + \frac{1}{2}\text{O}_2$ , and a radical process,  $\text{HNO}_3 \rightarrow \text{OH} + \text{NO}_2$ . The increased  $\text{G}(\text{OH})$  from  $\text{HNO}_3$  solutions is directly proportional to the  $\text{HNO}_3$  concentration. The 100-ev yields of the radiolytic products produced by  $\text{Co}^{60}$  gamma irradiation of

sulfuric acid solutions are presented graphically as a function of the stoichiometric sulfuric acid concentration. The postirradiation reaction occurring in  $\text{Ce}(\text{IV})$ - $\text{H}_2\text{SO}_4$  solutions is shown to be a reaction between  $\text{H}_2\text{SO}_5$  and  $\text{Ce}(\text{IV})$  ions. The mechanism probably involves the hydrolysis of  $\text{H}_2\text{SO}_5$  to  $\text{H}_2\text{O}_2$ , which then reacts with  $\text{Ce}(\text{IV})$ . By means of low-temperature cells and absorption spectrophotometry, the formation of ozone in liquid oxygen was observed, *in situ*, by alternate gamma irradiation and UV absorption measurement. Ozone formation was found to be linear with dose for five increments of  $5.4 \times 10^{17}$  ev/g. Preliminary G values for ozone formation in liquid oxygen at  $77^\circ\text{K}$  are 14 to 16 molecules of ozone per 100 ev. Alpha radiolysis of biphenyl produced higher (a factor of less than 10) yields of gas (mostly hydrogen) and "polymer" than were reported for electron and gamma radiolysis. The average molecular weight of the polymer was about three times that of biphenyl, and evidence was obtained for hydrogenation. Ionic complexes,  $[\text{XeC}_2\text{H}]^+$  and  $[\text{XeC}_2\text{H}_2]^+$ , were observed in a  $\text{C}_2\text{H}_2$ -Xe mixture irradiated by 90-ev electrons in a mass spectrometer. The complex  $[\text{XeC}_2\text{H}]^+$  results from a second-order process, whereas  $[\text{XeC}_2\text{H}_2]^+$  is formed by a third-order process. No complexes were observed in mixtures of  $\text{C}_2\text{H}_2$  and the other noble gases. The yield obtained for the alpha radiolysis of  $\text{C}_2\text{H}_4$  agreed with the previously reported value. The main products of this radiolysis are  $\text{H}_2$  and polymer. The  $\text{H}_2$  comes from irradiation of the polymer. (auth)

**32188** RADIATION INDUCED FREE RADICALS IN ALANINE AND SOME RELATED AMINO ACIDS. ELECTRON SPIN RESONANCE STUDIES. Svein Prydz and Thormod Henriksen (Norwegian Radium Hospital, Oslo). *Acta Chem. Scand.*, 15: 791-802(1961). (In English)

Free radicals, radioinduced in polycrystalline samples of  $\alpha$ -alanine and some related amino acids, were studied by electron spin resonance techniques. The results show that the observed spectra very often represent the composite pattern of more than one radical. Qualitative changes occur in the electron spin resonance spectra, demonstrating that secondary processes take place at a fairly slow rate in the solid state. The number of induced radicals was measured as a function of the radiation dose as well as of the time after the end of the exposure. The dose effect curves are straight lines up to a certain dose level and then flatten out. This occurs before any saturation effects are to be expected. Time studies demonstrate the surprisingly high stability of radicals induced and trapped within solid amino acids. For the amino acids studied, 5-50 electron volts were found necessary to induce one primary radical with lifetime long enough to be observed. These low values seem to imply that the radicals originate not only from ionizations, but also from excitation processes which are subsequently followed by rupture of chemical bonds. Conceivably the radical fragments induced may take part in reactions with intact neighbor molecules, a circumstance which may explain the observed qualitative changes in the resonance patterns. (auth)

**32189** VIBRATIONAL EXCITATION OF DIATOMIC MOLECULES DUE TO NUCLEAR RECOIL. J. Fiutak and L. Wolniewicz (N. Copernicus Univ., Torun, Poland). *Bull. acad. polon. sci., Sér. sci., math., astron. et phys.*, 9: 557-60(1961). (In English)

The probability of the vibrational and rotational excitation of molecules from nuclear recoil was investigated. A method was developed for calculations in the approximation of the Morse potential. Numerical results were

obtained for hydrogen. It was found that the probability of vibrational excitation increases appreciably in the anharmonic case and that the mean energy is independent of the form of the potential. (M.C.G.)

**32190** STUDY OF THE EFFECT OF GAMMA RADIATION ON THE MOLECULE OF PENTOBARBITAL.

J. A. R. Cloutier, Bruce C. Flann, and Jane M. Manson (Dept. of National Health and Welfare, Ottawa). *Can. J. Phys.*, 39: 1465-76 (Oct. 1961).

Modern instrumental techniques were used to investigate the effect of gamma radiation on the molecule of pentobarbital. The results were correlated with each other and with those from a biological test. The main effect of radiation appeared to be centered about the two substituents of the molecule at the number 5 position. (auth)

**32191** A CONTINUOUS ELECTROPHORETIC SEPARATION OF THE RADIOACTIVE MIXTURE  $^{115}\text{Cd}$ - $^{114}\text{In}$ . Z. Konrad-Jakovac and Z. Pucar (Institute "Ruder Bošković," Zagreb). *Croat. Chem. Acta*, 33: No. 1, 33-4 (1961). (In English)

Two experiments on the continuous electrophoretic separation of  $\text{Cd}^{115}$ - $\text{In}^{114}$  are described. The supporting electrolyte was a 0.1 N solution of KI in 0.1 N HBr. Sharp separation was achieved for a mixture of 108 mg Cd + 172 mg In and 4000 mg Cd + 396 mg In in 24 hours, showing the wide range of concentration to which the method is applicable. (auth)

**32192** CHEMICAL EFFECTS INDUCED BY  $\text{Co}^{60}$   $\gamma$  IRRADIATION IN AQUEOUS SOLUTIONS OF TOLUENE AND PHENOL. M. A. Bertolaccini Manzitti, P. L. Bertolaccini, and L. Pucini (Corso per le Applicazioni Mediche dell'Energia Nucleare, Leghorn). *Energia nucleare (Milan)*, 8: 519-24 (Aug. 1961). (In English)

Products formed by  $\gamma$  irradiation of deaerated aqueous solutions of toluene and other aromatic compounds were examined. In irradiation of oxygen-free solutions of these compounds, dimerization and hydroxylation reactions take place; particular attention was then directed to establish which of the isomeric compounds are formed in order to study the influence of some substituent groups on free radical substitution in aromatic systems. A mechanism is put forward to account for the experimental results. (auth)

**32193** FAST RESPONSE PULSE TESTS USE GAMMA MILKING. J. E. Gwyn (Shell Oil Co., Deer Park, Tex.). *Ind. Eng. Chem.*, 53: 907-8 (Nov. 1961).

The usefulness of radiotracers for flow studies is extended into the shorter time range. Thus the residual contamination problem associated with long life isotopes is minimized. The separation of gamma-emitting barium-137 from its parent cesium-137 by resin exchange permits the frequent separation and injection of a sharp pulse of the short half life (2.6 minutes)  $\text{Ba}^{137}$  using an automatic device known as the gamma milker. The penetrating gamma rays of the tracer are measured by scintillation detectors mounted on the external surface of the process vessel thus eliminating the need of removing samples for subsequent analyses. High speed recording equipment permits the measurement of pulse responses ranging from a few tenths to 100 seconds. (auth)

**32194** EFFECT OF GAMMA IRRADIATION ON THE CATALYTIC ACTIVITY OF ZINC OXIDE AND CHROMIC OXIDE FOR THE DECOMPOSITION OF METHANOL. A. J. Teller, F. L. Poska, and H. A. Davies (Univ. of Florida, Gainesville). *Intern. J. Appl. Radiation and Isotopes*, 11: 123-30 (Sept. 1961). (In English)

The effect of gamma radiation on the catalytic activity of an n- and a p-type semi-conductor catalyst was determined. The reaction studied was the vapor-phase decomposition of methanol under continuous flow conditions. Under dose rates ranging from 80,000 to 450,000 r/hr an increase in the catalytic activity of the n-type zinc oxide catalysts and a decrease in activity of the p-type chromic oxide catalysts were observed. The degree of change was related to the inherent activity of the catalyst. A saturation effect of irradiation appeared to exist. Low inherent activity n-type catalysts approached the activity of a high inherent activity n-type catalyst when subjected to  $\gamma$ -radiation. All p-type catalysts approached the same level of activity when exposed to  $\gamma$  radiation. (auth)

**32195** THE MECHANISM OF THE RADIATION CHEMICAL DEGRADATION OF AMINO ACIDS. I. THE DEGRADATION OF  $\alpha$ -AMINO BUTYRIC ACID. J. Kopoldova, J. Liebster, and A. Babicky (Biological Inst., Czechoslovak Academy of Sciences, Prague). *Intern. J. Appl. Radiation and Isotopes*, 11: 139-44 (Sept. 1961). (In English)

The mechanism of the radiolysis of  $\alpha$ -aminobutyric acid under the influence of  $\gamma$ -irradiation was investigated. A reaction pattern is suggested. An explanation of the degradation mechanism is attempted on the bases of calculations of the 100 ev yields. The main path of radiolysis was elucidated. (auth)

**32196** DISPROPORTIONATION AND RECOMBINATION REACTIONS OF METHYL AND  $n$ -PENTYL RADICALS. M. H. J. Wijnen (Mellon Inst., Pittsburgh). *J. Am. Chem. Soc.*, 83: 3752-4 (Sept. 20, 1961). (RRL-56)

Methyl and  $n$ -pentyl radicals were produced by photolysis of 2-heptanone. The primary process in the photolysis of this compound may be given by  $\text{CH}_3\text{CO}(\text{CH}_2)_4\text{CH}_3 + h\nu \rightarrow \text{CH}_3\text{COCH}_3 + \text{C}_4\text{H}_9$ . Several reactions of methyl and  $n$ -pentyl radicals have been investigated. Data at 63 and at 91° indicate  $k_3/(k_2^{1/2} k_5^{1/2}) = 1.6 \pm 0.1$ . Approximate values of 0.1 and 0.2 are suggested for  $k_4/k_3$  and  $k_6/k_5$ , respectively. These figures are compared with similar ratios of rate constants for other alkyl radicals. (auth)

**32197** HYDROGEN ABSTRACTION FROM HYDROCARBONS BY METHYL RADICALS FROM THE PHOTOLYSIS OF METHYL IODIDE IN SOLID NITROGEN. C. David Bass and George C. Pimentel (Univ. of California, Berkeley). *J. Am. Chem. Soc.*, 83: 3754-8 (Sept. 20, 1961).

Methyl iodide was photolyzed at 20°K, in solid matrix materials,  $\text{N}_2$ , Kr, and Xe, containing hydrocarbons  $[\text{C}_2\text{H}_6]$  or  $[(\text{CH}_3)_3\text{CH}]$  or deuterated hydrocarbons  $[\text{CD}_4]$ ,  $[\text{CH}_3\text{CD}_3]$ , or  $[(\text{CH}_3)_3\text{CD}]$ . Hydrogen abstraction was studied by infrared detection of  $\text{CH}_4$  and  $\text{CH}_3\text{D}$ . In the solid the abstraction products can be attributed to methyl radicals with an effective temperature in the range 1000-3000°K. Furthermore, the products obtained from photolysis of methyl iodide with ethane present as well as those from photolysis of ethyl iodide in nitrogen, indicate that about 85% of the reactions probably occur within the cage at the site of photon absorption. These studies provide information concerning the dissipation of the energy of a hot radical constrained within a reactive cage. (auth)

**32198** CHEMICAL EFFECTS IN FISSION PRODUCT RECOIL. V. THE VALENCY STATE OF FISSION PRODUCT IODINES FORMED IN URANYL IODATE. D. Hall and G. N. Walton (A.E.R.E., Harwell, Berks, Eng.). *J. Inorg. & Nuclear Chem.*, 19: 16-26 (Sept. 1961). (In English)

When uranyl iodate is irradiated in a reactor the iodates are partly decomposed to form reduced forms of io-



dine. Several isotopes of iodine are formed as fission products and are distributed in different proportions between the oxidized and reduced forms of iodine. The percentage in the reduced form for  $I^{131}$  is 14% and for  $I^{133}$  18%; these values are independent of the amount of fission over a wide range. For  $I^{132}$  the reduced form amounts to about 36%, and for  $I^{135}$  54–68%, dependent upon the amount of fission. These results are discussed in terms of the independent yields of the various isobars involved in the fission process, and it is shown that the valency state adopted is modified by the environment in which they are formed. (auth)

**32199** ASSOCIATED PROCESSES TO THE SZILARD-CHALMERS EFFECT IN CRYSTALS. I. HEXAMMINOCOBALTIC NITRATE. SECTION 2. THERMAL ANNEALING OF THE CRYSTALLINE DEFECTS AFTER IRRADIATION. T. Costea (Inst. of Atomic Physics, Bucharest). *J. Inorg. & Nuclear Chem.*, 19: 27-37 (Sept. 1961). (In English)

The thermal annealing of neutron irradiated  $\{Co(NH_3)_6\}(NO_3)_3$  was investigated to determine the order of the fast annealing processes, the activation energy, the fraction annealing as a function of the temperature, and the effect of the history of the sample on the annealing process. It was observed that the fast thermal annealing process formally obeys first-order kinetics. Strictly the kinetics may be explained by processes distributed in activation energy. The maximum of the activation energy spectrum is about 0.78 ev. The fraction destined to anneal is proportional to the temperature, but the saturation value of the retention for different samples heated at the same temperature is not the same. It was observed that the radiation history of the sample has a great influence on the annealing process and a quantitative treatment of the effects is determined. (auth)

**32200** THE THERMAL ANNEALING OF  $^{60}Co$  IN IR-RADIATED TRIS-(ETHYLENEDIAMINE)-COBALT(III) NITRATE. L. L. Williams, N. Sutin, and J. M. Miller (Brookhaven National Lab., Upton, N. Y.). *J. Inorg. & Nuclear Chem.*, 19: 175-6 (Sept. 1961). (BNL-5083). (In English)

The rate of annealing of the  $Co^{60}$  was studied by heating samples of the irradiated salt for various lengths of time in an oven at 60 or 100° before analysis. The retention of samples annealed at room temperature or at 60° and then annealed at 100° reached the same value as that of a sample annealed at 100° throughout. This suggests that completing annealing reactions do not occur in this system and that the retentions of all irradiated samples would reach the same plateau-value on prolonged annealing, regardless of the annealing temperature. It was concluded that the annealing of  $Co^{60}$  in tris-(ethylenediamine)-cobalt(III) nitrate cannot be readily described in terms of two first order reactions. (P.C.H.)

**32201** PRODUCTION OF CARRIER-FREE  $I-131$  FROM TELLURIC ACID BY AN ADSORPTION METHOD. G. Toth (Central Research Inst. for Physics, Budapest). *J. Inorg. & Nuclear Chem.*, 19: 186-7 (Sept. 1961). (In English)

The method and results of experiments to study the removal of iodine from solutions containing telluric acid are given. The active and inactive impurities of the sample, analyzed by gamma and optical spectroscopy, showed no more impurities than in the redistilled water used. The gamma spectrum showed no activity other than  $I^{131}$ , and a decay curve followed for ten half lives showed not more than 0.05% by contamination. (P.C.H.)

**32202** RADIATION-INDUCED IONIC POLYMERIZATION AT LOW TEMPERATURE. Yoshizo Tsuda (Toyo Rayon Co., Ltd., Otsu, Japan). *J. Polymer Sci.*, 54: 193-9 (Sept. 1961). (In English)

The copolymerization, by means of ionizing radiation, of acrylonitrile with styrene or methyl methacrylate was investigated at  $-78^\circ C$  in bulk and in various solvents. The copolymerization proceeds by a cationic mechanism in methylene chloride solution, by a free radical mechanism in bulk, and by both an anionic mechanism and a free radical mechanism in dimethyl formamide, diethylamine, toluene, and ethyl bromide solutions. The rate of anionic polymerization of acrylonitrile increases with dilution of monomer. The cationic polymerization in methylene chloride solution was shown to be caused by the catalytic action of hydrogen chloride which is formed from the irradiation of chlorinated hydrocarbon. It was concluded that the main factor in the induction of an anionic polymerization of acrylonitrile is the large reactivity of the monomer in anionic polymerization. (auth)

**32203** RADIATION-INDUCED IONIC POLYMERIZATION OF ISOPRENE. Yoneho Tabata, Ryosuke Shimozaawa, and Hiroshi Sobue (Japanese Assn. for Radiation Research on Polymers, Tokyo). *J. Polymer Sci.*, 54: 201-8 (Sept. 1961). (In English)

The  $\gamma$ -ray induced polymerization of isoprene was investigated in the temperature range of  $-78^\circ$  to  $40^\circ C$ . The following variables were studied: the dependence of polymerization rate on temperature; the effects of DPPH and pyridine on the polymerization at various temperatures; the dependence of the polymerization rate on dose rate at  $-78^\circ$  and  $20^\circ C$ ; and the structure of the polyisoprenes obtained by various temperatures. Although the Arrhenius plot of the polymerization rate did not yield a linear relation, the total polymerization rate was successfully separated into radical and ionic contributions. The polymerization rate was proportional to the square root of dose rate at  $20^\circ C$ , whereas it was proportional to the first power of the dose rate at  $-78^\circ C$ . The structure of polyisoprene prepared at  $-78^\circ C$  is closely similar to that of cationically polymerized polyisoprene. The partially ionic mechanism of the radioinduced polymerization of isoprene was elucidated in the investigation. It was concluded that a cationic mechanism is operative at low temperatures whereas a radical mechanism predominates at higher temperatures. (auth)

**32204** MONOMER REACTIVITIES IN RADIATION-INDUCED GRAFT COPOLYMERIZATION. George Odian, Albert Rossi, Elliot Ratchik, and Terese Acker (Radiation Applications Inc., Long Island City, N. Y.). *J. Polymer Sci.*, 54: S11-13 (Sept. 1961).

The departure of radioinduced graft copolymerization from the behavior predicted by the copolymer composition equation was studied. Mixtures of styrene with methyl acrylate, 4-vinyl pyridine, and acrylonitrile were graft copolymerized to low density polyethylene at  $25 \cdot dM_1/dM_2$  values obtained, based on ultraviolet and elemental nitrogen analyses, agreed with the values based on the infrared analyses, which were made, to within 5%. The  $dM_1/dM_2$  values were observed to be lower than those calculated from the copolymer composition equation. The results on the polyethylene-styrene-acrylonitrile grafting system confirm, qualitatively but not quantitatively, previous work on the same system. From the results two conclusions are made. Apparently the reactivity of the more polar monomer (methyl acrylate, 4-vinyl pyridine, acrylonitrile) in the comonomer mixture is increased in graft copolymerization

relative to that in homocopolymerization and/or the reactivity of the less polar monomer (styrene) is decreased. The growing graft polymer chain is attached to a very large, bulky group (the polyethylene backbone) and this may alter the reactivities of the monomers. (P.C.H.)

**32205 RADIATION-INDUCED EFFECTS ON WATER-SOLUBLE POLYMERS IN THEIR AQUEOUS SOLUTIONS. II. CO-CROSSLINKING BETWEEN TWO DIFFERENT POLYMERS.** Tatsuo Matsuda (Government Industrial Research Inst., Nagoya, Japan), Chen-Chong Lin, and Kiyoshi Hayakawa. *Kobunshi Kagaku*, 18: 492-5(1961). (In Japanese)

Gamma-ray induced effects were studied on the mixtures of two different water soluble polymers, polyvinylalcohol, polyvinylpyrrolidone, polyacrylamide, methyl cellulose, and polymethacrylic acid, in aqueous solutions in which the individual polymer is dissolved below a critical concentration for gelation. It was found that networks between two different polymer components (co-network) were built up if both polymers were of the crosslinking type, and that, gel formation was retarded if one of two polymers was degradative-type. Co-crosslinking, which occurred at the system of polyvinylalcohol-polyvinylpyrrolidone, was examined by the measurements of the viscosity of irradiated solutions and the solubility of irradiated polymers in methanol. It was observed that there is a linear relationship between the gelation dose for the mixture of two polymers, polyvinylalcohol-polyvinylpyrrolidone or -polyacrylamide, and the content of the mixture. The network formation of crosslinking-type polymers in their aqueous solution was retarded by the presence of methyl cellulose. The general mechanism for co-crosslinking of these polymers in aqueous solution is briefly discussed. (auth)

**32206 RECOIL-ATOM REACTIONS AT LOW TEMPERATURE.** Slobodanka Veljković and Garman Harbottle (Brookhaven National Lab., Upton, N. Y.). *Nature*, 191: 1287-8 (Sept. 23, 1961).

Neutron irradiated alkali chromates were analyzed by dissolution in aqueous solutions at  $-55^{\circ}\text{C}$  and sodium bromacetate in methanol at  $-60^{\circ}\text{C}$ . The aqueous solutions were eutectic mixtures of 33.7 gm of lithium chloride to 100 gm of water, freezing at about  $-70^{\circ}\text{C}$ . Similar experiments were also carried out with potassium and ammonium chromates. In both experiments, lower retentions were observed for low temperature conditions. Retention data obtained by low temperature techniques, including the complete thermal history of the specimens are tabulated. (P.C.H.)

**32207 BEHAVIOUR OF NEUTRON-IRRADIATED AMMONIUM SULPHATE ON THERMAL ANNEALING.** Nikola Getoff and Masaru Nishikawa (Institut für Radiumforschung und Kernphysik, Vienna). *Nature*, 192: 61-2(Oct. 7, 1961).

Since the thermal annealing of neutron irradiated ammonium dichromate passed through a maximum above  $170^{\circ}\text{C}$ , experiments with ammonium sulfate were carried out in order to see if the anomaly is also common to other ammonium compounds. The thermal annealing of the irradiated ammonium sulfate was carried out in an oven at various temperatures and various heating periods in the presence of air. The retention at  $100 \pm 0.5^{\circ}\text{C}$  was plotted against heating time and found to follow a typical annealing process curve. However, at temperatures above  $150^{\circ}\text{C}$ , the curve passed through a maximum. The anomaly was most conspicuous at  $180 \pm 0.5^{\circ}\text{C}$ . Consequently, two counteracting processes, thermal annealing and reduction, are taking place in the irradiated ammonium sulfate during the period of heating at temperatures greater than  $150^{\circ}\text{C}$ . (P.C.H.)

**32208 RADIOLYSIS OF LIQUID ACETONE: EFFECT OF DOSE-RATE AND LINEAR ENERGY TRANSFER.** R. Barker (Atomic Energy Research Establishment, Harwell, Berks, Eng.). *Nature*, 192: 62-3(Oct. 7, 1961).

In a general study of the radiolysis of liquid acetone, it was found that the yields of products are affected both by the linear energy transfer of the radiation and also the dose rate. The G value for carbon monoxide production was found to decrease with increasing dose rate. The variation of the product ratios with dose rate are explained in terms of competing reactions and the overlapping of diffused spurs at higher dose rates. Comparison of the results of  $\gamma$  and proton irradiation illustrates markedly the effect of dose rate and linear energy transfer on the products of the radiolysis of acetone.  $G_{\text{CH}_3}$  (total) for  $\gamma$  irradiation is equal to  $2.47 \pm 0.25$ , compared with  $G_{\text{CH}_3}$  (total) equal to  $2.24 \pm 0.25$  for proton irradiations. Scavenging experiments (with iodine) showed that at low dose rates at least half of the yield of methyl ethyl ketone was unaffected. (P.C.H.)

**32209 THE PRECIPITATION OF LEAD DURING DECOMPOSITION OF LEAD IODIDE BY ELECTRON IRRADIATION.** A. J. Forty (Univ. of Bristol, Eng.). *Phil. Mag.* (8), 6: 895-905(July 1961).

Crystals of lead iodide decompose under electron irradiation into metallic lead and iodine gas. Observations were made on the mode of decomposition, particularly on the way in which precipitates of lead nucleate and grow inside the parent crystal. At low rates of decomposition the lead precipitates almost uniformly in the form of very small ( $100 \text{ \AA}$ – $1000 \text{ \AA}$  in diameter) misoriented crystallites. There is some slight tendency for deposition to occur along dislocations. At high rates of decomposition the lead precipitates in larger platelet form with a definite degree of orientation between the precipitate and the lead iodide. These platelets appear to nucleate and grow within cavities which are produced inside the parent crystal by the electron bombardment. The observations suggest an interesting mechanism for the growth and spreading of decomposition throughout the crystal. (auth)

**32210 PARAMAGNETIC NITROGEN OXIDES IN IRRADIATED POTASSIUM HALIDES.** Claude Jaccard (Argonne National Lab., Ill.). *Phys. Rev.*, 124: 60-6(Oct. 1, 1961).

In x-ray irradiated single crystals of KCl, KBr, and KI doped in the melt with nitrate or nitrite, six triplets and one singlet are observed in electron paramagnetic resonance between  $-190^{\circ}\text{C}$  and room temperature. The trapping mechanism producing the centers is indicated by the behavior of the electron paramagnetic resonance signal during optical or thermal release of free electrons (from F centers) or holes (from  $\text{Cl}_2^{\cdot-}$ ), and the chemical nature of the centers by selective doping methods. In all three salts these tests have identified NO interstitials (anisotropic up to room temperature, almost axial symmetry, principal paramagnetic axes in [100], [011], and  $[0\bar{1}1]$  directions); NO in positive-ion vacancies (isotropic); and  $\text{NO}_2^{\cdot-}$  in negative-ion vacancies (anisotropic below  $-145^{\circ}\text{C}$ , axial symmetry, axis in [111] direction). In KCl and KBr,  $\text{NO}_2^{\cdot-}$  in negative-ion vacancies (anisotropic, axial symmetry, axis in [110] direction, visible below  $-125^{\circ}\text{C}$ ), and oxygen molecules (anisotropic, almost axial symmetry, axes in [100], [011],  $[0\bar{1}1]$  directions, visible below  $-100^{\circ}\text{C}$ ) have been identified. Information regarding the bonding in the molecules has been obtained. Two isotropic triplets are not identified. The relative concentrations are different in the various host crystals, and the linewidth increases according to the halogen nuclear moment. (auth)



**32211** CHEMICAL YIELDS OF IONIZING RADIATIONS IN AQUEOUS SOLUTIONS: EFFECT OF ENERGY OF ALPHA PARTICLES. Sheffield Gordon and Edwin J. Hart (Argonne National Lab., Ill.). Radiation Research, 15: 440-51 (Oct. 1961).

Integral ferric ion yields,  $G_0(\text{Fe}^{3+})$ , were obtained for the Fricke dosimeter as the energy of a collimated  $\alpha$ -particle beam entering the solution was varied from 4.5 to 0.2 Mev by means of mica absorbers. When the energy of the  $\alpha$  particle is reduced from 4.5 to 2.5 Mev,  $G_0(\text{Fe}^{3+})$  decreases from 4.79 to 4.02. Thereafter,  $G_0(\text{Fe}^{3+})$  rises to 7.10 as the energy is decreased from 2.4 to 0.06 Mev. Calculated values of the local yield,  $G_1(\text{Fe}^{3+})$ , show a similar dependence on energy of the  $\alpha$  particle.  $G_1(\text{Fe}^{3+})$  is 6.61 at 4.5 Mev, decreases to a minimum value of 3.35 at 1.0 Mev, and then rises to 7.10 at 0.06 Mev. With  $G_0(\text{Fe}^{3+})$  known as a function of energy for  $\alpha$  particles,  $G_0(\text{Fe}^{3+})$  may be calculated for recoil atoms from some nuclear disintegration reactions involving  $\alpha$  particles. Range-energy curves are also reported for  $\alpha$  particles in the energy range from 4.5 to 0.2 Mev. (auth)

**32212** A COMPARISON OF THE EFFECTS OF X-RAYS AND ALPHA RAYS ON SOME PROTEINS AND AMINO ACIDS IN DILUTE AQUEOUS SOLUTION. P. Alexander and D. Rosen (Royal Cancer Hospital, London). Radiation Research, 15: 475-88 (Oct. 1961).

Serum albumin, ribonuclease, tryptophan, tyrosine, and some other amino acids in dilute aqueous solution were irradiated with x (or  $\beta$ ) and  $\alpha$  rays, and changes were observed in sedimentation of serum albumin and in the absorption spectra of all the materials. For serum albumin the effects of x and  $\alpha$  radiations differed, and, although the protein could be protected by the addition of cysteine against x radiation, there was little protection against  $\alpha$  radiation. No oxygen effect was noted for either radiation. The protein was little affected by hydrogen peroxide but was attacked by ozone to produce changes closely similar to those after  $\alpha$  irradiation, although the effect of  $\alpha$  radiation was not brought about by ozone. Alpha radiation attacked the indole ring of tryptophan twice as readily as did x radiation. The spectral changes found on the  $\alpha$  irradiation of tryptophan closely matched those appearing on the  $\alpha$  irradiation of serum albumin. The effects of x radiation on tryptophan could be greatly reduced by adding protective compounds to the solution, but tryptophan was protected against  $\alpha$  radiation to a much lesser extent. It is proposed that the action of x radiation on proteins is exerted by free radicals which attack all the common amino acids, whereas the action of  $\alpha$  radiation is by a short-lived molecular product which preferentially attacks the tryptophan residue or molecule. It is proposed that the molecular species concerned is a metastable excited state of hydrogen peroxide. Consideration is given to the role of the molecular product of  $\alpha$  radiation in determining the relative biological efficiencies of densely and sparsely ionizing radiations. (auth)

**32213** DIMERIZATION OF TETRAHYDROPYRANOLS INDUCED BY GAMMA IRRADIATION IN AQUEOUS SOLUTION. A. J. Bailey, S. A. Barker, I. R. L. Lloyd, and R. H. Moore (Univ. of Birmingham, Eng.). Radiation Research, 15: 532-7 (Oct. 1961).

Rates of dimerization, mainly to vic-glycols, were measured for  $\gamma$ -irradiated evacuated aqueous solutions of model tetrahydropyranols.  $G_{\text{dimer(s)}}$  for tetrahydro-2-(hydroxymethyl)pyran was much greater (maximum 1.95) than those for tetrahydro-2-hydroxypyran ( $G_{\text{dimers}}$  approximately  $5.2 \times 10^{-2}$ ) and tetrahydro-4-hydroxypyran ( $G_{\text{dimers}}$

approximately  $4.0 \times 10^{-2}$ ). Dimerization at  $C_6$  was indicated therefore as the major contribution in the initial formation of a polymer from glucose. (auth)

**32214** POLYMER PRODUCTION FROM CARBOHYDRATES. A. J. Bailey, S. A. Barker, and M. Stacey (Univ. of Birmingham, Eng.). Radiation Research, 15: 538-45 (Oct. 1961).

Some twenty model carbohydrates, which contain a single functional group in the tetrahydropyran ring, were examined for their ability to produce nondialyzable polymers when submitted to  $\gamma$  irradiation in deaerated aqueous solution. The polymer yield was interpreted on the basis of the contribution made by the various substituent groups. (auth)

**32215** THE RADIOLYSIS OF NITRATE IONS DISPERSED IN A POTASSIUM BROMIDE MATRIX. A. Russell Jones and Robert L. Durfee (Oak Ridge National Lab., Tenn.). Radiation Research, 15: 546-52 (Oct. 1961).

Data are presented on the radioinduced decomposition of nitrate ions dispersed in a potassium bromide lattice. It is shown that the nitrite ion found in an aqueous solution of the irradiated solid existed in the solid prior to dissolution and did not arise by reaction of stabilized intermediates with the water. The equivalence of the initial slopes of the curves for the decomposition of nitrate ion and the formation of nitrite ion confirms this result. It is shown that no equilibrium can be obtained during the decomposition of the nitrate ion because it is decomposed when dispersed in a KBr lattice with the formation of unidentified products which do not recombine to form an equivalent amount of nitrate ion. This means that it is not possible to equate the amount of nitrite ion found after irradiation with the amount of nitrate ion decomposed. It is shown that oxygen atoms diffuse within the potassium bromide lattice, since some nitrate ion is produced during the decomposition of the nitrite ion. (auth)

**32216** ERRORS IN THE INVESTIGATION OF CRYSTALLIZATION AND PRECIPITATION RELATED TO RADIOCHEMICAL IMPURITIES OF RADIOACTIVE ISOTOPES. G. I. Gorshtein. Radiokhimiya, 3: 246-55 (1961). (In Russian)

Errors involved in microcomponent fractionation during crystallization and precipitation are investigated. General formulas were developed for calculating corrective coefficients of transition from distorted coefficient values describing fractionation processes. (R.V.J.)

**32217** SEPARATION OF CARRIER-FREE  $\text{Mn}^{54}$  FROM NEUTRON IRRADIATED IRON BY EXTRACTION METHOD. V. I. Levin, I. V. Meshcherova, and V. K. Samrov. Radiokhimiya, 3: 417-21 (1961). (In Russian)

A method for extracting  $\text{Mn}^{54}$  from irradiated iron (neutron reaction  $\text{Fe}^{54}(\text{n,p})\text{Mn}^{54}$ ) by organic solvent extraction from hydrochloric acid was developed. The yield of carrier-free manganese and its radiochemical purity were determined. (R.V.J.)

**32218** SEPARATION OF CARRIER-FREE  $\text{Zr}^{95}$  BY EXTRACTION WITH n-DICRESYLPHOSPHATE-CHLOROFORM. S. A. Potapova. Radiokhimiya, 3: 422-7 (1961). (In Russian)

Extraction of carrier-free  $\text{Zr}^{95}$  from nitric and hydrochloric solutions by n-dicresyl phosphate- $\text{CHCl}_3$  mixture is analyzed, and the method of n-dicresyl phosphate synthesis is described. Conditions conducive to quantitative separation of  $\text{Zr}^{95}$  from microquantities of Sr, Cs, Y, Ce(III), and Nb are found. The feasibility of yttrium extraction from  $\text{Sr}^{90} + \text{Y}^{90}$  by n-dicresyl phosphate- $\text{CHCl}_3$  is confirmed. (R.V.J.)

**32219** ADSORPTION OF RADIOACTIVE ISOTOPES ON POLYMER ADSORBENTS INCAPABLE OF ION EXCHANGE. I. ADSORPTION OF ZIRCONIUM FLUOROPLASTIC-4 FROM HYDROCHLORIC SOLUTIONS. I. E. Starik, I. A. Skul'skii, and V. N. Shebetkovskii. *Radiokhimiya*, 3: 428-34(1961). (In Russian)

Zirconium adsorption on fluoroplastic-4 from hydrochloric solution, followed by desorption and extraction with tributyl phosphate is studied. The heat of zirconium adsorption from 10N HCl on fluoroplastic-4 is  $2.2 \pm 0.2$  kcal/mole. The adsorption magnitude as a function of concentration is described by the Freundlich isotherm  $\Gamma = 10^{-3} C^{0.91}$ . (R.V.J.)

**32220** ADSORPTION OF RADIOACTIVE ISOTOPES ON POLYMER ADSORBENTS INCAPABLE OF ION EXCHANGE. II. ADSORPTION OF Zr ON PHOTOPLASTIC-4 FROM ACID SOLUTIONS OF ALKALI METAL SALTS. I. E. Starik, V. N. Shebetkovskii, and I. A. Skul'skii. *Radiokhimiya*, 3: 435-9(1961). (In Russian)

Adsorption of  $Zr^{95}$  in 1N nitric, hydrochloric, and hydrobromic acids, in the absence of colloidal forms and products of hydrolytic polymerization, was analyzed. In Zr adsorption on photoplastic-4, the salting-out force of similar salts is of the order  $Li < H \ll Na < K < NH_4$  in HCl and  $H < Li \ll Na < NH_4 < K$  in HBr and  $HNO_3$ . (R.V.J.)

**32221** CONCENTRATION OF RADIOACTIVE ISOTOPES BY FROTHY GELATIN. V. V. Pushkarev. *Radiokhimiya*, 3: 498-500(1961). (In Russian)

Concentration of  $Sr^{89}$ ,  $Ce^{144}$ ,  $Ru^{106}$ ,  $Nb^{95}$ , and  $Zr^{95}$  from aqueous solutions by precipitation with iron hydroxide in frothy gelatin is described. (R.V.J.)

**32222** ENRICHMENT OF  $U^{237}$  BY SZILARD-CHALMERS METHOD USING URANYL DIBENZOYL METHANE. N. P. Martynov, V. A. Bochkarev, and A. A. Lbov. *Radiokhimiya*, 3: 508-9(1961). (In Russian)

$U^{237}$  enrichment by the Szilard-Chalmers method using uranyl dibenzoylmethane is described. The enrichment factor is  $\sim 10^3$ . (R.V.J.)

**32223** REACTION OF MAGMA WITH RADIOACTIVE ISOTOPES IN DYNAMIC CONDITIONS. S. A. Voznesenskii, V. F. Bagretsov, V. V. Pushkarev, and V. L. Zolotavain. *Radiokhimiya*, 3: 510-11(1961). (In Russian)

Sorption of Ce, Ru, Zr, Nb, P, and S was studied considering the fineness of the dolomite, pH of the solution, and the presence of tri-sodium phosphate. The results show practically complete separation from aqueous solution. (R.V.J.)

**32224** ELECTRON SPIN RESONANCE SPECTRA OF  $\gamma$ -IRRADIATED n-HEXADECENE-1 AND n-HEXADECANE. P. B. Ayscough, A. P. McCann, C. Thomson, and D. C. Walker (The University, Leeds, Eng.). *Trans. Faraday Soc.*, 57: 1487-91(Sept. 1961).

Electron spin resonance spectra were observed from paramagnetic species present in  $\gamma$  irradiated n-hexadecene-1 between  $-196$  and  $0^\circ C$ , and in n-hexadecane between  $-196$  and  $14^\circ C$ . The rate of production of trapped radicals in n-hexadecene-1 at  $-196^\circ C$  is approximately 3.5 radicals/100 ev absorbed energy. Possible interpretations of the spectra are discussed in relation to the radiation chemistry of the system. (auth)

**32225** THE WELDING OF TEFLON AND OTHER POLYMERIC MATERIALS BY THE LOCALIZED ACTION OF NEUTRON RADIATION. I. M. Barkalov, V. I. Gol'danskii, B. G. Dzantiyev, and Ye. V. Yegorov (Inst. of Physical Chemistry, Academy of Sciences, USSR).

*Vysokomolekulyarnye Soedineniya*, 2: 1801-4(1960). (In Russian)

A simple process was developed for welding Teflon and other polymeric materials by irradiating the materials to be welded with thermal neutrons after pretreatment of the material surface with boron and lithium compounds. The following polymeric materials were welded: teflon-polystyrene, teflon-polymethyl methacrylate, polystyrene-polymethyl methacrylate, polyethylene-polystyrene, polyethylene-polymethacrylate. Prior to irradiation, the surfaces to be welded were treated with solutions of boron and lithium compounds and subsequently exposed to a thermal neutron flux. The tear resistance of the teflon-polystyrene weld as a function of the megarentgen dose applied to the surface, at constant  $B_2O_3$  concentration, was investigated, and the results are shown in graphical form. The tear resistance of the teflon-polystyrene weld is  $120 \text{ kg/cm}^2$ . The mechanism involved in welding polymeric materials by localized neutron irradiation is discussed. The thermal effect is assumed to be the main factor in this type of welding. Triple layer welding of polyethylene and teflon and other polymeric and non-polymeric materials can be effected by applying interlayers of lithium and boron containing polystyrene films. (OTS)

**32226** EMR SPECTRA AND THE RATE OF ACCUMULATION OF PRODUCTS FORMED DURING RADIOLYSIS OF FROZEN AQUEOUS SODIUM NITRATE SOLUTIONS. V. A. Sharpatyi and Yu. N. Molin (Karpov Inst. of Physics and Chemistry, USSR). *Zhur. Fiz. Khim.*, 35: 1465-73 (July 1961). (In Russian)

Intermediate radicals ( $NO_2$ ,  $HNO_2$ ) formed during irradiation of frozen aqueous sodium nitrite and nitrite solutions were identified with the aid of an EMR assembly. The rate of accumulation and disappearance of these intermediates was investigated under various conditions of irradiation (sodium nitrate concentration, temperature, and pH). The effect of various additions ( $O_2$ , glycerine, ethyl alcohol, alkali) on the yield of radicals formed from the nitrate was determined. In order to find the mechanism of the radiolytic reduction of the nitrate ion a comparison was made of the yields of radical and end products ( $NO_2^-$ ,  $H_2$ ,  $O_2^-$ ) of the system. (auth)

**32227** SEPARATING NEUTRON IRRADIATED DISPERSIONS. (to United Kingdom Atomic Energy Authority). British Patent 878,871. Oct. 4, 1961.

An apparatus is described for removing a portion of the liquid from a neutron-irradiated dispersion of a fissionable material in a liquid moderator. In the apparatus, the liquid is vaporized by the self heat developed by radioactive decay of the dispersion, and the vaporization is carried out in two stages to reduce evaporator contamination, the second stage beginning when the delayed neutron emission from the dispersion has ceased. The apparatus is particularly applicable to the case where the liquid moderator is  $D_2O$  and the fissionable material is  $UO_2$ . (D.L.C.)

## Separation Processes

**32228** (HW-63051) THE RECOVERY OF FISSION PRODUCT RARE EARTH SULFATES FROM PUREX 1WW. E. J. Wheelwright and W. H. Swift (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 10, 1961. Contract AT(45-1)-1350. 12p.

Cerium-144 and promethium-147, accompanied by rare earths resulting from fission or decay can be removed from



Purex 1WW in >90% yield as an insoluble, crystalline sodium-rare earth double sulfate. Precipitation is initiated by a one-to-three hour equilibration at 90°C and centrifugation at 90°C to take advantage of the lower solubility of the double sulfate salt at a higher temperature. The sulfate concentration should be one molar and the solution pH at the time of precipitation should be 0.5 to 1.5. The addition of tartrate ion to complex the iron allows the use of a higher pH and sulfate concentration, gives a more complete separation from iron, and a quantitative recovery of the rare earths. The double sulfate precipitate can be dissolved in dilute nitric acid or converted to the carbonate and then dissolved to yield a solution for further processing. The double sulfate precipitation of the rare earths, with tartrate added, gives a good separation from impurities. One-cycle decontamination factors of 150 for Zr-Nb and 1100 for Ru-Rh have been achieved in laboratory tests. Tests in the Purex head-end equipment with up to two-megacurie batches of cerium have corroborated the laboratory results. Decontamination factors of 70 for iron, 10 for zirconium, 20 for niobium and 25 for ruthenium have been obtained. It was found wise to limit the batch size because of heat generated by the cerium-144. Otherwise the intense decay heat leads to partial calcination in the centrifuge and to difficulty in redissolution. (auth)

**32229** (HW-66320) DISSOLUTION OF POWER REACTOR FUEL CORES. H. T. Blaine (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 26, 1960. Contract AT(45-1)-1350. 49p.

Molybdenum alloys of uranium are difficult to dissolve in nitric acid. At low acid concentrations, the molybdenum precipitates, carrying down significant amounts of uranium. However, the addition of ferric nitrate to low acid solutions prevents the precipitation of molybdenum. Also, above 13 M acid the molybdenum precipitate contains little uranium allowing the supernate to be processed in a conventional manner for uranium-plutonium recovery. The dissolution rate of uranium-3% molybdenum alloy is proportional to the second power of the nitrate ion concentration in the absence of ferric ion and to the third power of the nitrate concentration in the presence of ferric ion. Typical rates with ferric ion were 42 mils per hour at 3.9 M nitrate and 104 mils per hour at 6.0 M nitrate. Uranyl ion suppresses the dissolution rate of alloy. With 1.0 M uranyl nitrate, the dissolution rate is about one third the predicted rate. Uranium-3% molybdenum alloy dissolved in nitric acid-ferric nitrate solutions with the stoichiometry:  $U + 4.2 HNO_3 + 0.95 O_2 \rightarrow UO_2(NO_3)_2 + 2.2 NO_2 + 2.1 H_2O + 230 \text{ kcal}$ . Uranium dissolves in nitric acid at a rate proportional to the 2.7 power of the nitrate ion concentration. The rates range from 1.7 mils per hour at 4.4 M nitrate to 35 mils per hour at 13 M nitrate. Uranium dissolves in nitric acid-uranyl nitrate solutions with the stoichiometry:  $U + 4 HNO_3 + O_2 \rightarrow UO_2(NO_3)_2 + 2 NO_2 + 2 H_2O + 264 \text{ kcal}$ . The dissolution rate of uranium dioxide 92% theoretical density sintered pellets is proportional to the 1.2 power of the nitric acid concentration and ranges from 6 mils per hour at 0.6 M acid to 70 mils per hour at 5.5 M acid. Uranium dioxide dissolves in nitric acid with the stoichiometry:  $UO_2 + 3 HNO_3 + 0.25 O_2 \rightarrow UO_2(NO_3)_2 + NO_2 + 1.5 H_2O + 17.2 \text{ kcal}$ . The dissolution rates of the four core materials are the same for recirculating and batch dissolvers. (auth)

**32230** (HW-67674) FLOWSHEET FOR SEPARATION OF PLUTONIUM FROM THORIUM AND URANIUM. L. E. Bruns (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 7, 1960. Decl. Jan. 4, 1961. Contract W-31-109-Eng-52. 6p.

A flowsheet is presented for the separation of Pu from Th and U, and for the separation of Pu from some unusual Pu wastes (e.g. chloride wastes). The process includes preparation of the Pu-containing materials (e.g. by crushing and grinding, steam oxidation, etc.); dissolution or leaching of the materials; feed preparation; and solvent extraction using 20% TBP in  $CCl_4$ . The feed may be adjusted to handle all ratios of Pu/U/Th. (T.F.H.)

**32231** (HW-68786) INCORPORATION OF ION-EXCHANGE IN THE HOT SEMIWORKS SOLVENT EXTRACTION STRONTIUM FACILITY. L. A. Bray (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 9, 1961. Contract AT(45-1)-1350. 10p.

Studies of Dowex 50W 12-X 40-60 mesh resin were conducted to determine the feasibility of an ion-exchange installation in the Sr purification solvent extraction facility. At a 50% Sr breakthrough, a citrate feed at pH 3.5 to 2.5 will permit a Sr loading of 17 to 40 g/l while complexing Ce; a decontamination factor of 20 for Ce under these conditions appears possible. The radiation stability of citric acid up to  $4 \times 10^8$  r was found to be adequate. The elution of Sr from the resin column will permit a Sr product concentration of 5 to 20 g/l. (D.L.C.)

**32232** (IS-220) TEMPERATURE AND FLOW RATE EFFECTS ON THE ION-EXCHANGE SEPARATION OF ERBIUM AND THULIUM. Irvin Leroy Sellers and J. E. Powell (Ames Lab., Ames, Iowa). May 1960. Contract W-7405-eng-82. 57p.

The concept of a theoretical plate has been applied as a column operation parameter to evaluate the effects of flow rate and temperature on the separation of erbium and thulium with HEDTA using an ion-exchange technique. It has been shown that for separations made at constant temperatures the overlap between the pure forms is directly proportional to the flow rate at all practical flow rates and temperatures. The changes in the HETP were easily explained in terms of the ion-exchange kinetic theory. A decrease would be expected in the HETP for any other change in the system which would facilitate the diffusion of ions through the resin particle, i.e., resin of small particle size or a resin of low cross-linkage. (auth)

**32233** (IS-332) EQUILIBRIUM DISTRIBUTION STUDIES OF DYSPROSIUM NITRATE-ERBIUM NITRATE-NITRIC ACID-TRIBUTYL PHOSPHATE SYSTEMS. Michael Robert Dinnin, Jr., and Morton Smutz (Ames Lab., Ames, Iowa). Nov. 1960. Contract W-7405-eng-82. 51p.

Separate equilibrium data were obtained for the distribution of  $Dy(NO_3)_3-HNO_3$ ,  $Er(NO_3)_3-HNO_3$ , and  $Dy(NO_3)_3-Er(NO_3)_3-HNO_3$  systems between water and tributyl phosphate. Equilibrium data for the  $Dy(NO_3)_3-HNO_3$  and  $Er(NO_3)_3-HNO_3$  systems were correlated in such a manner that the total distribution of solutes and nitric acid could be found for the  $Dy(NO_3)_3-Er(NO_3)_3-HNO_3$  system. The separation factor between  $Dy(NO_3)_3$  and  $Er(NO_3)_3$  is shown as a function of the total molality of the aqueous phase. A method is presented for predicting the concentrations of  $Dy(NO_3)_3$ ,  $Er(NO_3)_3$ , and  $HNO_3$  in an organic phase of tributyl phosphate from their concentrations in the aqueous phase at equilibrium, and the results of the method are compared with experimental data. (D.L.C.)

**32234** (IS-337) ANION EXCHANGE SEPARATIONS OF METAL IONS IN PARTIALLY NONAQUEOUS SOLUTIONS. Donald John Pietrzyk and J. S. Fritz (Ames Lab., Ames, Iowa). Nov. 1960. 119p.

A systematic approach to anion exchange in partially nonaqueous solvents was initiated. Distribution coefficients

of metal ions for Dowex 1 X8, chloride form resin in organic solvent-water mixtures containing hydrochloric acid were measured. The organic solvents used were methyl alcohol, ethyl alcohol, isopropyl alcohol, acetone, and dioxane. When the organic solvent concentration was increased and the hydrochloric acid concentration is held constant, the distribution coefficient increased. Similarly, if the hydrochloric acid concentration was increased while holding the organic solvent concentration constant, the distribution coefficient increased. The order of the distribution coefficients in the alcoholic-acid-water mixtures was found to be: isopropyl > ethyl > methyl alcohol. In many cases, distribution coefficients were found to be significantly higher than in water-hydrochloric acid systems. Several metal ions [thorium(IV), nickel(II), calcium(II), rare earths(III), chromium(III), and vanadyl(IV)] which do not adsorb in aqueous hydrochloric acid were found to be adsorbed when an organic solvent is present. Three elution schemes for metal ion separations were proposed. In the first scheme the eluting agents contain 0.3M hydrochloric acid with varying percent of ethyl alcohol. The eluting agents in the second scheme contain 55 percent isopropyl alcohol with varying concentrations of hydrochloric acid. The last scheme contains 0.2M hydrochloric acid and a mixture of methyl and ethyl alcohol totaling 96 percent. Successful separations of a number of metal ion mixtures were performed using these elution schemes. (auth)

**32235** (IS-340) SEPARATION OF METAL IONS ON CHELATING RESIN. Raymond David Szidon and J. S. Fritz (Ames Lab., Ames, Iowa). May 1961. Contract W-7405-eng-82. 32p.

Attempts were made to separate components of metal ion mixtures on columns of iminodiacetate type chelating resin. Distribution coefficients of metal ions in the system of sulfosalicylic acid and citric acid were calculated to determine the proper pH for the most efficient separations. Separations of metal ion mixtures using citric or sulfosalicylic acid solutions as eluting agents were for the most part, successful, although incomplete elutions were observed in some cases. Fluoride solutions were also found to be effective eluting agents for the separation of metal ions using columns of chelating resin. Separations of metal ion mixtures with either a 0.1M HF-0.1M NaF solution at pH 4.0 or a 0.1M HF acid solution at pH 5.5 as the eluting agent were accomplished. (auth)

**32236** (ORNL-3118) A STUDY OF DISSOLUTION OF REACTOR FUELS CONTAINING ZIRCONIUM IN A TITANIUM VESSEL. W. E. Clark and T. A. Gens (Oak Ridge National Lab., Tenn.). Oct. 23, 1961. Contract W-7405-eng-26. 25p.

Titanium, which serves adequately as the construction material in processes which have been proposed for dissolution of reactor fuels containing stainless steel, might also be used for the dissolver vessel in dissolution of fuels containing Zr. Ti was corroded at rates as low as 2 to 20 mils/month during dissolution of Zr alloys at rates of 0.3 to 1.2 mils/min ( $\sim 20$  mg/cm<sup>2</sup> · min) in 6 M NH<sub>4</sub>F or 0.5 M HBF<sub>4</sub> containing dissolved Zr, 0.4-6 M chromate, and 0.5-6 M NH<sub>4</sub>NO<sub>3</sub> or HNO<sub>3</sub>. In 16 M HNO<sub>3</sub>-0.58 M Cr-1.9 M F-0.5 M Zr, the Zircaloy-2 dissolution rate was >0.1 mil/min and the Ti corrosion rate <3 mils/month. Aggressive localized corrosion, apparently associated with chromate depletion, was observed in the ammonium fluoride and fluoboric acid dissolvents. (auth)

**32237** (ORNL-3194) EXTRACTION OF NEPTUNIUM FROM ACIDIC SOLUTIONS BY ORGANIC NITROGEN AND PHOSPHORUS COMPOUNDS. Boyd Weaver (Oak

Ridge National Lab., Tenn.). Oct 19, 1961. Contract W-7405-eng-26. 22p.

Neptunium distribution coefficients from acid nitrate, chloride, and sulfate solutions by several organic nitrogen and phosphorus compounds were measured as functions of several extraction variables, including neptunium valence, acid and salt concentration, and reagent concentration. Extractability by all the reagents varied in the order Np(IV) > Np(VI) > Np(V). Except for primary amines, all reagents extracted Np(IV) much more strongly from nitrate than sulfate solutions. Among organonitrogen compounds the order of extractability of Np(IV) was: quaternary > tertiary > primary and secondary from nitrate solutions but primary > secondary > tertiary from sulfate solutions. Neptunium(IV) nitrate extractions with the different extractants passed through maxima at widely different acid concentrations. In most cases, extraction increased when nitric acid was replaced by nitrate salt. Extraction was usually approximately proportional to the square of the reagent concentration. (auth)

**32238** (AEC-tr-4842) EXTRACTION OF SULFURIC ACID AND URANYL SULFATE BY TRIBUTYL PHOSPHATE. V. B. Shevchenko and Yu. F. Zhdanov. Translated by Lydia Venters (Argonne National Lab., Ill.) from Radiokhimiya, 3: No. 1, 7-9(1961). 4p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 17020.

**32239** THE APPLICATION OF CELLULOSE POWDER TREATED WITH TRI-N-OCTYLPHOSPHINE OXIDE (TOPOC) TO COLUMN CHROMATOGRAPHY. E. Cerrai and C. Testa (CISE, [Milan]). Energia nucleare (Milan), 8: 510-18(Aug. 1961). (In English)

Cellulose powder treated with tri-n-octylphosphine oxide (TOPOC) is prepared and applied to column chromatographic separations of elements. The possibility of separating different ionic forms of the same element is also shown as well as that of selectively extracting and concentrating trace amounts of elements from dilute solutions. The following separations are described: Fe<sup>3+</sup>-Co-Ni; U<sup>6+</sup>-Th-La; La-Th-Zr; Al-Cu-Fe<sup>3+</sup>-U<sup>6+</sup>; Pb-Bi-Fe<sup>3+</sup>; Cu-Bi-Sc-U<sup>6+</sup>; Y-Th-Sc; Ni-Pd-Pt-Au; Mn-Bi-Hg; As<sup>3+</sup>-Sb<sup>3+</sup>; V<sup>4+</sup>-Ti; Fe<sup>2+</sup>-Fe<sup>3+</sup>; Cr<sup>3+</sup>-Cr<sup>6+</sup>; U-Th (traces) from Fe-Ti; U and Th from dilute solutions and from solutions containing several extraneous elements. The favorable results and advantages previously given by cellulose treated with tri-n-octylamine (TOAC) are confirmed with TOPOC. (auth)

**32240** TANTALUM AND NIOBIUM. A Staff-Industry Collaborative Report. Donald J. Soisson, J. J. McLafferty, and James A. Pierret. Ind. Eng. Chem., 53: 861-8(Nov. 1961).

A liquid-liquid extraction process for making tantalum and niobium boosts production rates 200% over the original process, and increases purity of the refractory metals from 99.7% to more than 99.9%. Key to the method is a series of mixer-settler boxes which operate on the principle of countercurrent extraction. Tantalum and niobium fluorides are fed into the boxes, and are separated from each other on the basis of solubility in methyl isobutyl ketone and aqueous solution at various acid concentrations. (auth)

**32241** TEMPERATURE EFFECTS ON URANYL NITRATE AND TETRAVALENT PLUTONIUM EXTRACTION BY MIXED SOLVENTS. V. B. Shevchenko, I. A. Fedorov, and V. S. Smelov. Radiokhimiya, 3: 256-60(1961). (In Russian)



Studies of temperature effects on uranyl nitrate and tetravalent plutonium extraction from 2 M  $\text{HNO}_3$  by diisooamyl ether phosphoric acid (DAP) and tributyl phosphate (TBP) in xylene show that the extraction rate drops with a temperature increase from 10 to 60°C. The formation constant of the mixed complex  $\text{UO}_2[(\text{C}_5\text{H}_{11}\text{O})_2\text{POO}]_2 \cdot \text{TBP}$  varies from  $2.20 \times 10^4$  to  $0.87 \times 10^4$  during the temperature increase while the formation constant of  $\text{Pu}[(\text{C}_5\text{H}_{11}\text{O})_2\text{POO}]_4 \cdot \text{TBP}$  varies very little. (R.V.J.)

**32242** EXTRACTION OF Po IN VARIOUS VALENCE STATES. I. E. Starik and N. I. Ampelogova. Radiokhimiya, 3: 261-71(1961). (In Russian)

In hydrochloric acid and in the presence of  $\text{H}_2\text{O}$  and  $\text{SO}_2$  polonium is in the divalent state and in the presence of chloride the hexavalent state. Diethyl ether extracts from hydrochloric acid only Po(VI) in acido-complex forms and TBP extracts Po(IV) and Po(II). In nitric acid media Po is reduced to its lower valence state in 1.5 to 2.5 M  $\text{HNO}_3$ ; at higher  $\text{HNO}_3$  concentrations polonium is oxidized to Po(VI). Polonium is in disproportion in all nitric acid solutions at all valencies. TBP is capable of extracting from nitric acid solutions only low valence Po, while diethyl ether extracts only Po(VI). Oxidation of Po by nitric acid and potassium dichromate mixture results in a transition to anionic ( $\text{PoO}_4^{2-}$ ). (R.V.J.)

**32243** EXTRACTION OF CESIUM BY CARBOXYLIC ACIDS. S. M. Karpacheva, N. M. Adamskii, and V. V. Borisov. Radiokhimiya, 3: 272-83(1961). (In Russian)

The distribution of microquantities of  $\text{Cs}^{134}$  between an aqueous solution and aliphatic acids (or aliphatic acid in benzene and isooctane) was studied in relation to  $\text{NaNO}_3$  concentration and pH of the aqueous phase. The calculated magnitude of cesium extraction from  $\text{NaNO}_3$  was  $(3.55 \pm 0.35) \cdot 10^{-3}$ . (R.V.J.)

**32244** ADSORPTION OF URANYL NITRATE FROM ORGANIC SOLVENTS BY MEANS OF ANION EXCHANGE RESINS. V. M. Vdovenko, A. A. Lipovskii, and M. G. Kuzino. Radiokhimiya, 3: 365-71(1961). (In Russian)

The adsorption of uranyl nitrate from organic solvent by means of anion exchange resins is related to complexing. Uranyl nitrate sorption on anion exchange resin is determined by the composition of the solution in the resin and possibly by formation of strong uranyl nitrate compounds with given organic solvents. The feasibility of using anion exchange for uranium separation from organic extractors and aqueous-organic solutions is postulated. The similarity of the mechanism of uranium and other element sorption from organic solvents by anion exchange resins, extraction by means of amine nitrates in inert diluents, and extraction by oxygen bearing organic solvents is discussed. (R.V.J.)

**32245** ON THE MECHANISM OF Pu(IV) EXTRACTION FROM SULFATE SOLUTIONS BY PRIMARY ALKYLAMINE. V. M. Vdovenko, A. A. Lipovskii, and S. A. Nikitina. Radiokhimiya, 3: 396-402(1961). (In Russian)

The mechanism of Pu(IV) extraction from sulfate solutions by primary amines is investigated. It is shown that Pu(IV) is separated from aqueous sulfate solutions as  $(\text{RNH}_3)\text{Pu}(\text{SO}_4)_4$ . The aminosulfate is not extracted by chloroform. The identical Pu(IV) complex formed in nitratosulfate solution extraction is confirmed by separation and by absorption spectra. It is postulated that aminosulfate is separated from nitratosulfate solutions due to the presence of a dispersed phase in chloroform formed by aminonitrate. (R.V.J.)

**32246** EXTRACTION OF NITRIC ACID AND URANYL NITRATE WITH TRI-N-NONYLAMINE AND TRI-N-DECYLAMINE IN BENZENE. V. M. Vdovenko, M. P. Koval'skaya, and E. A. Smirnova. Radiokhimiya, 3: 403-10(1961). (In Russian)

The distribution of uranyl nitrate between the nitric acid solutions and tri-n-nonylamine and tri-n-decylamine in benzene was analyzed. It is shown that tri-n-nonylamine and tri-n-decylamine in benzene separate nitric acid from aqueous solutions in quantities exceeding amine concentrations. At nitric acid concentrations 1, 6, and 12M the ratios of nitric acid to amine in the organic phase are 1, 2, and 3. It was also found that the extraction of the first and third nitric acid molecule is followed by transition to an organic aqueous phase, indicating that the amine salt appears in the organic phase as  $\text{R}_3\text{N} \cdot \text{HNO}_3 \cdot \text{H}_2\text{O}$ . Cryoscopic data confirm polymerization of the amine salt. Uranyl nitrate is extracted by amines in the dehydrated state. (R.V.J.)

**32247** EXTRACTION OF AMERICIUM WITH TRIBUTYLPHOSPHATE. V. I. Zemlyanukhin and G. P. Savoskina. Radiokhimiya, 3: 411-16(1961). (In Russian)

It was found that in the presence of nonextractable nitrate the Am distribution coefficient increases with increased nitrate concentrations and diminishes with increased concentrations of  $\text{HNO}_3$ . The salting-out equivalents are calculated for a certain group of nitrates. The extraction of Am improves with increased cation potential and Am activity coefficient. Complexes of  $\text{Am}(\text{NO}_3)_3 \cdot n(\text{TBP} \cdot m\text{HNO}_3)$  in the organic phase, formed during extraction from strong  $\text{HNO}_3$  (>8M) solutions, and the lack of stable complexes in aqueous solutions were observed. (R.V.J.)

**32248** SEPARATION OF MATERIALS BY INTERMITTENT EXTRACTION (PARTITION OF  $\text{Mo}^{99}$  FROM URANIUM FRACTIONS). R. I. Alekseev and O. N. Polevaya. Radiokhimiya, 3: 458-65(1961). (In Russian)

Formulas are derived for calculating controlling factors in  $\text{Mo}^{99}$  separation from U fractions by means of intermittent extraction. The separation of  $\text{Mo}^{99}$  is achieved by transfer into silicon molybdenum heteropoly acid, which in turn is extracted from aqueous solution by butyl alcohol and transformed again into aqueous solution by adding chloroform to the alcohol solution. In the transition the heteropoly acid suffers only negligible losses, while the concentration of the uranium fractions drops with each extraction. (R.V.J.)

**32249** EFFECTS OF SATURATED MONATOMIC ALCOHOLS AND SIMPLE ETHERS ON THE EXTRACTION OF  $\text{U}^{4+}$ ,  $\text{Pu}^{4+}$ ,  $\text{Zr}^{4+}$ ,  $\text{Ce}^{3+}$ , AND  $\text{Nb}^{5+}$  FROM NITRIC ACIDS BY TRI-N-BUTYL PHOSPHATE. V. B. Shevchenko, A. S. Solovkin, L. M. Kirillov, and A. I. Ivantsev. Radiokhimiya, 3: 503-5(1961). (In Russian)

The influence of pure n-butyl, n-hexyl, and n-octyl alcohols and diethyl, dibutyl, diheptyl, and dioctyl ethers on  $\text{U}^{4+}$ ,  $\text{Pu}^{4+}$ ,  $\text{Zr}^{4+}$ ,  $\text{Ce}^{3+}$ , and  $\text{Nb}^{5+}$  extraction from nitric acid solutions by tributyl phosphate ( $\text{TBP} = 1$  mole % and nitric acid  $\approx 3\text{M}$ ) was studied. Distribution coefficients of  $\text{UO}_2(\text{NO}_3)_2$ ,  $\text{Pu}(\text{NO}_3)_4$ ,  $\text{Zr}(\text{NO}_3)_4$ , and  $\text{Ce}(\text{NO}_3)_3$  diminish with increased molecular polarization in pure diluents. The deviation of distribution coefficients of  $\text{UO}_2(\text{NO}_3)_2$  and  $\text{Pu}(\text{NO}_3)_4$  from the ideal distribution law is determined by polarization in pure diluent. (R.V.J.)

**32250** PROCESS FOR THE SEPARATION OF ZIRCONIUM AND HAFNIUM. Oskar Glemser. British Patent 874,510. Aug. 10, 1961.

An improved process is outlined for separating Zr and

Hf by solvent extraction. The process comprises distributing Zr and Hf oxychlorides between an aqueous chloride ion-containing solution (usually 2 to 13  $N$  HCl) and a halogenated hydrocarbon (e.g., chloroform) containing an organic amine (e.g., tribenzylamine) at 20 to 60°C. One advantage of the process is that Zr oxychlorides obtained from dressing of Zr ores can be used directly. (D.L.C.)

**32251 IMPROVEMENTS IN OR RELATING TO THE PROCESSING OF NUCLEAR REACTOR FUEL ELEMENTS.** John Arnold Williams and Leonard Lowes (to United Kingdom Atomic Energy Authority). British Patent 879,041. Oct. 4, 1961.

A process for recovering U from irradiated fuel elements also containing Al and Si is given in which solvent extraction of U is not materially affected by the presence of Si. The process is based on the solubility of Si in acid deficient aluminum nitrate solutions and comprises the steps of dissolving the fuel element in a limited quantity of  $HNO_3$  such that the resulting solution is acid deficient and extracting uranyl nitrate with an organic solvent. The acid deficiency of the solution preferably is between 0.6 and 2  $M$ . (D.L.C.)

**32252 RECOVERY OF RADIOACTIVE CESIUM.** (to United Kingdom Atomic Energy Authority). French Patent 1,187,511. Mar. 2, 1959.

Radioactive cesium is precipitated from nitric acid fission product solutions as the phosphotungstate. The precipitate is dissolved in aqueous NaOH, reprecipitated with  $H_2SO_4$ , and redissolved in ammonia. This solution is treated with a strongly basic anion exchange resin, such as De-acidite FF or Amberlite IRA 400, which adsorbs phosphorus and tungsten and leaves cesium in solution from which it can easily be recovered as an inorganic salt by neutralization and evaporation. (NPO)

**32253 PROCESS FOR OBTAINING PLUTONIUM IN HIGH CONCENTRATION.** K. Diebner. French Patent 1,226,416. July 11, 1960.

In a reactor working with natural or enriched uranium a portion of uranium-238 is transformed into plutonium. During the development of plutonium in a uranium-238 containing fuel element the concentration of the plutonium increases more in a superficial layer than in the heart of the element until an equilibrium concentration of plutonium is attained, with the result that more than 20% of the developed plutonium may be present in this superficial layer. The superficial layer is separated from the rest of the fuel element after a certain irradiation time in the reactor, by any suitable mechanical or chemical method in order to obtain plutonium in high concentration. The same method can be used for breeding thorium-232 into uranium-233 of high concentration. (NPO)

**32254 TREATMENT OF NUCLEAR FUELS.** (to U. S. Atomic Energy Commission). French Patent 1,229,237. Mar. 21, 1960.

Irradiated fuel, such as uranium oxides or U-Al alloys, are dissolved in  $KAlCl_4$  at 400 to 800°C. Formation of  $Al_2O_3$  can be prevented by passing  $CCl_4$  through the molten mass. Aluminum is added, the mass is cooled to 400 to 500°C and the two phases are separated. The metallic phase consists of an Al-U alloy while the salt phase contains the plutonium and the greater part of the fission products. (NPO)

**32255 IMPROVEMENTS IN THE ELIMINATION OF RADIOACTIVE RUTHENIUM AND CESIUM.** (to Atomic Energy of Canada Ltd.). French Patent 1,231,396. Apr. 11, 1960.

Gases or vapors are freed from ruthenium and cesium by contacting them at 400 to 1000°C with a mixture or alternate layers of an oxide of iron, nickel, chromium, cobalt, and/or titanium on the one hand and calcium silicate on the other. (NPO)

**32256 METHOD OF SEPARATING URANIUM AND ZIRCONIUM.** (to Dow Chemical Co.). French Patent 1,233,910. May 9, 1960.

A pyrometallurgical method is described for the separation of uranium and zirconium in irradiated uranium-zirconium fuel alloys or mixtures. The material is reduced to a grain size of 3 mm and contacted with 1 to 10 times its weight of molten aluminum at 800 to 900°C. After the corroding action of the aluminum has ceased the mixture is cooled from 670 to 760°C and the liquid, consisting of uranium and aluminum, is separated from the  $ZrAl_3$  precipitates. The treatment can be repeated with the precipitate, but the total weight of aluminum consumed should not exceed 10 times the weight of the initial starting material. (NPO)

**32257 METHOD OF REGENERATING FUEL ELEMENTS.** (to U. S. Atomic Energy Commission). French Patent 1,237,764. June 27, 1960.

A method for processing irradiated Al-U or Al-Pu alloys consists of heating the alloys in a vacuum with  $ZnCl_2$  at 1000°C or with cryolite at 800 to 1000°C. The greater part of the aluminum sublimes as a halide, while a substantial part of the fission products is likewise eliminated. (NPO)

**32258 METHOD OF DISSOLVING ZIRCONIUM CONTAINING FUEL ELEMENTS.** (to U. S. Atomic Energy Commission). French Patent 1,251,767. Dec. 12, 1960.

Irradiated U-Zr composites are dissolved at 70 to 150°C in a fluorine containing acid to which a complexing agent is added, such as HF with at least 7 mol %  $NO_2$ . The insoluble zirconium complex is filtered off and the liquid treated with  $BF_3$  to convert the uranium and the fission products into volatile fluorides which are separated by fractional distillation. Other dissolving acids, such as fluorophosphoric, -arsenic, -antimonic, or -boric acid can be used, instead of  $NO_2$  metallic fluorides can be used as complexing agents. (NPO)



# ENGINEERING AND EQUIPMENT

## General and Miscellaneous

**32259** (61GL192) INVESTIGATION OF THE WEAR PROPERTIES OF GREEK ASCOLOY (AMS 5616) FOR THE NPR DIVERSION VALVE. R. E. Lee, Jr. (General Electric Co. General Engineering Lab., Schenectady, N. Y.). Sept. 15, 1961. Contract [AT(45-1)-1350]. 25p.

The sliding behavior of Greek Ascoloy, a Cr-Ni-W alloy steel was investigated in order to determine if it met the diversion valve sliding requirements of the New Production Reactor. A valve seat coating of Stellite 6 overlay was selected in the investigation in the event Greek Ascoloy in combination with itself was not acceptable. It was concluded that the sliding behavior of Greek Ascoloy in the Rc 31-33 heat treated condition was acceptable at loads to 1500 psi, when used in combination with a protective coating of Stellite 6 overlay. (M.C.G.)

**32260** (AD-258791) A HIGH INTENSITY PULSED X-RADIATION SOURCE. Frank D. Adams (Aeronautical Systems Div. Flight Dynamics Lab., Wright-Patterson AFB, Ohio). May 1961. 18p. (ASRMS-TM-61-3)

An idea is suggested for a pulsed magnetic x-ray device capable of generating high-intensity x radiation. Preliminary design criteria are developed from simple theoretical considerations. (auth)

**32261** (APEX-632) SUBROUTINE FOR SYSTEMATIC SAMPLING OF THREE CARTESIAN COORDINATES AND AN ENERGY VALUE. J. L. McGurn and J. R. Beeler (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Dec. 1, 1958. Contracts AF33(600)-38062 and AT(11-1)-171. 30p.

A subroutine for systematic sampling of three cartesian coordinates from a separable, cylindrically symmetrical space distribution and an energy value from an arbitrary distribution is described. This subroutine was written for the IBM 704 computer. (auth)

**32262** (APEX-670) DEVELOPMENT OF A DIELECTRIC VALVE AND FLUID. A. L. Spivak (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Aug. 9, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 15p.

Development of a dielectric valve capable of controlling, without moving parts, the flow of certain fluids is described. Special attention was given to controlling the flow of fluids developed especially for use with such a valve. (auth)

**32263** (CERN-PS/FS-3) PULSED PROTON SOURCE FOR HIGH CURRENT. [Fritz Schneider] (European Organization for Nuclear Research, Geneva). Jan. 1957. 6p.

The parameters involved in the design of a pulsed proton source for high currents are considered. A proton source is described with the following characteristics: r-f pulse time, 250  $\mu$ sec; extraction time, 10  $\mu$ sec; and cup current at 3 cm behind canal, 150 ma. (D.L.C.)

**32264** (HW-62223(Rev.)) REACTOR BUILDING STRUCTURAL STRENGTHS, REINFORCEMENT TECHNIQUES, AND SEALANT MATERIALS. Final Report, A CG-791 Containment Test. H. F. Jensen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 18, 1959. Revised Jan. 1, 1960. Contract AT(45-1)-1350. 29p.

Tests to determine the ability of structural components in existing reactor buildings to contain an internal pres-

sure of 0.3 psi indicate the following: The precast concrete roof tile of the 105 B, D, DR, and F Buildings will require restraint. An internal pressure of 0.2 psi will float the roof-tile. Small clips attached to the tile with epoxy adhesives successfully tied the tile to the structural steel. The corrugated asbestos cement panels of the 105-K reactor roofs could be similarly anchored. The paper tar roof membrane is satisfactorily bonded to the roof tile and essentially leak tight. The roofs should be recoated and possibly reinforced by a glass fiber incorporated in the coating material. The metal fascia of the roof line can be included in the sealing of the roof-wall junction by use of the approved caulks and coatings. The concrete block curtain walls of the 105 B, D, DR, F, and H Buildings appear capable of resisting internal pressures of 0.3 psi without additional reinforcement. Wall openings, such as doors and windows, would however increase load concentrations and require special consideration. The corrugated, asbestos cement, transite walls of the 105 C and K Reactors appeared sufficiently strong to withstand a maximum internal pressure of 0.3 psi without further reinforcement. Sealing of the building structures is necessary. It can be effectively accomplished with Thiokol caulks and Thiokol, Neoprene, or Hypalon coating materials. The tests indicated excellent adhesion, strength, and sealant properties. Sealing the wall apertures, such as openings for pipe and electrical conduit, can be effectively accomplished with the caulks specified. Where wide openings are to be sealed to conditions of excessive movement, heat, etc. is expected, silicone rubber foams have been developed and the application methods tested in and around reactor components. This type of sealant would be available where required. (auth)

**32265** (HW-69275) AN ANALOG COMPUTER STUDY OF THE STARTUP PROCESS IN AUTOCLAVE TEMPERATURE CONTROL SYSTEMS. C. D. Swanson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 1961. Contract AT(45-1)-1350. 41p.

The startup performance to be expected from an autoclave temperature control system using various types of control configurations is studied with the aid of an analog computer. The autoclave process transfer function is derived from measurements on a similar existing system. The effects of changing the ratio of the maximum process reaction rate to the apparent process dead time are determined. Simulation circuits for the various control configurations are derived. (auth)

**32266** (TID-7023) INSPECTION, STORAGE, HANDLING, AND INSTALLATION OF HIGH-EFFICIENCY PARTICULATE AIR FILTER UNITS. Humphrey Gilbert (Atomic Energy Commission, Washington, D. C.) and James H. Palmer (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 1961. 34p.

A guide for the inspection, storage, handling, and installation of high-efficiency particulate air filter units is presented. Precautions and recommendations are given. (M.C.G.)

**32267** (TID-13818) A LINEAR-GRADIENT MIXING DEVICE FOR VISCOUS SOLUTIONS. G. Lew Choules (Johns Hopkins Univ., Baltimore. McCollum-Pratt Inst.). [1961]. Contract AT(30-1)-1822. 11p.

A gradient mixing device is described which forms linear concentration gradients and is suitable for mixing

viscous liquids. Construction details are given and data are presented for gradients formed between 50% sucrose solution and water at room temperature. Statistical analysis showed that the slope of the regression line calculated from the data is constant within  $\pm 1.5\%$  for the 99% fiducial limits. (auth)

**32268** (UCRL-Trans-724) POSSIBILITIES AND LIMITATIONS OF TELEVISION MICROSCOPY. Helmuth Frenk. Translated for Univ. of California Lawrence Radiation Lab., Berkeley from Radio Mentor, No. 11, 887-93 (1960). 25p. (includes original, 7p.).

Areas of usefulness for television microscopy such as in demonstration, research, and in industrial or medical applications are discussed. A comparison is offered to establish those areas in which competing processes are superior and thus stake out the limits of this technology. (J.R.D.)

**32269** RIM REINFORCED OPENINGS. PART II. R. Kitching and J. Perkins. Nuclear Eng., 6: 423-5 (Oct. 1961).

In Part I a description was given of the methods of calculating stresses near rim reinforced openings in a vessel subjected to pressure. Methods of dealing with end thrusts on a branch were also given. These methods are now being extended, so that stresses may be estimated around a branch which is subjected to a bending moment. Results from these two methods are compared with those given when a bending moment is applied to an attachment rigidly connected to an infinite flat plate. The notation is given in Part I. (auth)

**32270** IMPROVEMENTS IN OR RELATING TO MIXER-SETTLER APPARATUS. Robert Marshall Menzies and David Watson Clelland (to United Kingdom Atomic Energy Authority). British Patent 873,599. July 26, 1961.

A mixer-settler apparatus is designed in which the flow ratio of light phase to heavy phase can be varied. The apparatus comprises alternate mixer and settler compartments with interconnecting ports. The ports are in the form of slots covered by members with holes smaller than the slots and which may be moved to expose varying portions of the slots. (D.L.C.)

**32271** IMPROVEMENTS IN OR RELATING TO GRABS FOR OPERATING IN LONG AND NARROW VERTICAL BORES. Norman Bradley and Jack Jones (to United Kingdom Atomic Energy Authority). British Patent 874,789. Aug. 10, 1961.

A grab for retrieving fuel elements from narrow reactor channels is designed which is operated, not by electrical means, but by a piston and thus is suitable for use in reactors cooled by a vapor, e.g., steam. A warning signal indicating coupling of the grab with a fuel element is actuated by a steam flow through a nozzle. (D.L.C.)

**32272** IMPROVEMENTS IN OR RELATING TO APPARATUS FOR THE REMOVAL OF LIQUID FROM ELASTOMER-CAPPED BOTTLES. Arthur James Howarth and William Rowell Guest (to United Kingdom Atomic Energy Authority). British Patent 878,504. Oct. 4, 1961.

An apparatus for removing radioactive liquids from elastomer-capped sampling bottles is designed wherein opening of the cap is avoided and venting of the bottles is provided. The apparatus comprises a shroud member for locating the bottle, a hollow piercing member for piercing the cap, and a draw-off tube movable into contact with the liquid through the piercing member with clearance for venting. (D.L.C.)

**32273** IMPROVEMENTS IN OR RELATING TO APPARATUS FOR MEASURING FLUID FLOW. George MacLen-

nan and John Lindley (to United Kingdom Atomic Energy Authority). British Patent 878,866. Oct. 4, 1961.

An apparatus for measuring fluid flow is designed which comprises a coiled pipe in the fluid flow path and an electrical instrument for measuring the pressure differential across the pipe. The apparatus is suitable for use in metering the gas evolved from a dissolver and thereby indicating the reaction rate in the dissolver. (D.L.C.)

**32274** IMPROVEMENTS IN OR RELATING TO MIXING MACHINES. Frank Butler and Herbert Boulton (to United Kingdom Atomic Energy Authority). British Patent 879,023. Oct. 4, 1961.

A mixing machine is designed comprising a set of mixing drums arranged to move in a closed circuit from a charging point to a discharging point and back again. The machine can be used to mix materials in accurately weighed batches and to deliver the mixed materials to a pelleting press operated on a specific pressing time cycle. (D.L.C.)

**32275** IMPROVEMENTS IN OR RELATING TO COUPLING DEVICES. Ivor Kent and Ralph Lee (to United Kingdom Atomic Energy Authority). British Patent 879,158. Oct. 4, 1961.

A coupling device of the kind described in British Patent 877,676 is modified so that connecting and disconnecting operations can be carried out on two members by remote control. The device is especially advantageous in a reactor where a shield plug-fuel element connection must be broken remotely. (D.L.C.)

**32276** LUBRICATION SYSTEM FOR DEVICES WORKING AT HIGH TEMPERATURES OR EXPOSED TO NUCLEAR RADIATION. (to Advance House, Inc.). French Patent 1,204,448. Jan. 26, 1960.

For devices working at high temperatures or exposed to radiation, so that the use of organic lubricants is impossible, the contiguous lubricated surfaces, moving relatively to each other, are separated by a lubricating film which may be constituted by a molten metal normally solid at the ambient temperature and indifferent to these surfaces. This metal is held in the molten state by heating means which may be mounted equally well inside the piece bounded by one of the lubricated surfaces or outside the lubricated system. The lubricant may also be constituted by a mixture of molten metal and an inorganic salt indifferent to this metal and to the surfaces. Particles of another solid lubricant can also be dispersed in the molten metal film. (NPO)

**32277** REMOVABLE CLOSING ORGAN FOR PRESSURE VESSELS AND MANUFACTURING PROCESS FOR SAME. (to Babcock & Wilcox Ltd.). French Patent 1,207,004. Feb. 12, 1960.

A removable closure provided with a plurality of openings, in particular for reactor pressure vessels, is described. This removable closure comprises two metal plates, disposed parallel and with an interspace between them. The plates are connected rigidly near their edges and a multicell structure subdivides the interspace into a plurality of cells. This multicell structure comprises a plurality of plates positioned perpendicularly to the first plates and serving to connect them. (NPO)

**32278** IMPROVEMENTS IN INDUSTRIAL DISMANTLABLE FILTERS FOR MICROFILTRATION, PARTICULARLY FOR FILTRATION OF NUCLEAR FLUIDS. (to Commissariat à l'Energie Atomique). French Patent 1,211,614. Oct. 12, 1959.

The filter consists of a closed, shielded chamber, provided with an inlet and an outlet, in which one or more



filter cells are mounted. Each cell consists of a number of parallel, disc-shaped filter elements of fritted metal, such as 18/8 Ni-Cr steel for filtering heavy water or bronze for filtering gaseous coolants. Three embodiments are described. (NPO)

**32279** IMPROVEMENTS RELATING TO PROCESS FOR THE ERECTION OF LARGE METAL CONTAINERS IN PARTICULAR OF SPHERICAL OR EGG-SHAPED FORM. (to Compagnie Francaise d'Enterprises). French Patent 1,212,046. Mar. 21, 1960.

In order not to have to handle wall components of great thickness for pressure containers, such as a vessel for a reactor, the vessel is erected by the superposition of a plurality of relatively thin elementary metal sheets. The vessel is first erected using a sheet of medium thickness (between 20 and 40 mm) and is afterwards reinforced by preformed pieces of sheet metal (between 6 and 15 mm) applied to the outer surface. Each of these layers is applied in two steps, firstly positioning the pieces of sheet metal and fixing these by bolting and secondly immobilizing them by welding. (NPO)

**32280** IMPROVEMENTS RELATING TO PRESSURE CONTAINERS. (to Blackburn & General Aircraft Ltd.). French Patent 1,218,206. May 9, 1960.

In order not to handle wall components of great thickness for pressure containers for a reactor, the vessel is constituted by a plurality of self-supporting containment shells disposed one inside the other, all having the same axis and each being made from a relatively thin steel sheet. Interspaces are formed between these containment shells constituting circuits of a coolant transmitting the pressure from the innermost to the outermost shell. Adjacent interspaces communicate with each other by a pump that increases the pressure of the coolant before it enters an inner interspace from the adjacent outer interspace. (NPO)

**32281** TIGHT CLOSING PROCESS OR DEVICE. (to Atomic Energy of Canada Ltd.). French Patent 1,218,877. May 13, 1960.

A device for tightly closing a container provided with a tubular element consists of a plug obturating the tubular element by a flexible disc. The disc is pressed against an annular rib of the tubular element by the plug, the plug being provided with a similar annular rib of a smaller diameter than the former rib, in order to transmit the pressure force to the disc. For the closing operation, the plug, the disc, and the rib on the tubular element are brought into contact, and the plug is fixed in this position. A push rod, sliding in an axial hole in the plug, is then pressed against the center of the disc, so that the latter is deformed and breaks contact with the plug rib. The position of the plug is then adjusted: it is brought into contact again with the outer surface of the disc. Finally the push-rod is retracted, so that the disc may come back part way towards its original position. Suitably the plug co-operates with the tubular element by a screw thread. (NPO)

**32282** DEVICE FOR JOINING CONDUITS OR ANALOGOUS ELEMENTS BY FLANGES E.G. FOR NUCLEAR REACTORS. (to Brown, Boveri & Cie and A. G. fur Unternehmungen des Eisen- und Stahlindustrie). French Patent 1,222,103. June 8, 1960.

In order to join conduits which are not readily accessible, two flanges may slide near the end of one of the conduits to be joined, the movements of these flanges being controlled by fluid pressure. The two flanges are connected by a bellows welded to the conduit at a median fold in a gas-tight manner so that at each side of this weld an extension

chamber is formed that can be brought into communication with a pressure fluid. The other conduit has a flanged end and comprises a support for receiving and centering the outer movable flange on the other conduit as the flanges are pressed against each other; a gasket ring is provided between these flanges. The movable flanges are connected in a rigid manner by a cylinder enclosing the bellows so that a pressure in the chamber of the bellows produces movement of the two connected flanges in the one or the other direction. (NPO)

**32283** METHOD FOR THE PROTECTION OF SWIMMING POOL REACTORS AND CONTAINERS FOR RADIO-ACTIVE WASTE DISPOSAL. M. Boutin and C. Duvivier. French Patent 1,228,856. Sept. 2, 1961.

A method for protecting the surfaces of a swimming-pool reactor or a container for radioactive waste disposal consists in positioning polyethylene sheets against the surfaces. These sheets are joined together by welding so as to form a continuous protecting layer and are held in place directly by the liquid pressure or are glued to a tar layer covering the surface. The polyethylene layer may also be fixed by nailing, the head of each nail being covered with a polyethylene disc welded at its edges to the protecting film. In another form the layer is composed of rigid square sheets welded together at the edges and fixed by nailing at the corners common to four adjacent sheets. The sheets contact the surface of the container only at their edge portions, the central part of each sheet being bulged. (NPO)

**32284** METHOD AND INSTALLATION FOR ELIMINATING RADIOACTIVE PARTICLES FROM GASES AND GASEOUS MIXTURES. (to Gesellschaft für Linde's Eismaschinen A. G.). French Patent 1,242,066. Aug. 16, 1960.

A flow-sheet is presented for the gradual cooling and drying of gaseous reactor coolants and shielding gases, the final elimination of radioactive particles being effected by adsorption at a temperature of less than  $-70^{\circ}\text{C}$ . (NPO)

## Heat Transfer and Fluid Flow

*Refer also to abstract 32932*

**32285** (ANL-5760) TWO-PHASE PRESSURE DROP IN A NATURAL CIRCULATION BOILING CHANNEL. B. M. Hoglund, R. J. Weatherhead, and T. R. Epperson (Argonne National Lab., Ill.). Aug. 1961. Contract W-31-109-eng-38. 41p.

Experimental two-phase pressure drop data were obtained from a  $\frac{1}{4} \times 2 \times 60$ -in. vertical, uniformly heated, test section. The local volume fraction of steam was measured simultaneously with the pressure drop, thus allowing separation of the terms for hydrostatic and acceleration pressure drops from the over-all static pressure drop. The results are expressed in terms of an average two-phase friction factor multiplier,  $\bar{R} = \Delta P_{TP} / \Delta P_{LO}$ , and are compared with the Martinelli-Nelson correlation, the Lottes-Flinn correlation, and a correlation combining that of Martinelli-Nelson and a flowrate parameter. The ranges of variables include: pressure from 150 to 600 psig; power density from 17.2 to 94.5 kw/liter of coolant; sub-cooling from  $4.8$  to  $25.7^{\circ}\text{F}$ ; exit qualities from 0.009 to 0.065; exit steam volume fraction from 0.19 to 0.77; and velocities from 2.56 to 3.43 fps. (auth.)

**32286** (ANL-6422) ON TWO-DIMENSIONAL FLUID MOTION THROUGH A SPOUT COMPOSED OF FOUR PLANE WALLS. Gordon C. K. Yeh (Ramo-Wooldridge. Div. of Thompson Ramo Wooldridge Inc., Canoga Park, Calif.). Oct. 17, 1960. Contract W-31-109-Eng-38. Sub-

contract No. 31-109-38-1159 for Argonne National Lab., Ill. 15p.

The mapping function, the complex potential, and the equations for the streamlines and equipotential lines for the fluid motion through a spout were obtained. One numerical example is presented and two limiting cases are discussed. (auth)

**32287** (APEX-612) PROGRESS REPORT ON PHOTO-ELASTIC STUDY OF CLADDED TUBES. R. Guernsey (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Feb. 21, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 26p.

A three dimensional photoelastic investigation carried out to determine the thermal stresses in both clad circular and hexagonal tubes due to differential thermal expansion between the clad and matrix (base) material is described. The investigation showed the existence of radial stresses in the matrix (base) material at the ends of the tube whose magnitude was 50% of that of the longitudinal clad stresses that occur some distance away from the ends of the tube. (auth)

**32288** (APEX-627) HEATED ANNULI COMPUTER PROGRAM. N. Clark, R. N. Noyes, and R. R. Jordan (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Aug. 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 54p.

The problem analysis and IBM 704 computing techniques for the determination of the aerothermodynamic performance of GE-ANPD concentric-ring-type fuel elements are presented. This program, known as the heated annuli program, will predict exit bulk fluid and ring temperatures, pressure drop, and flow distribution in each annulus of a multistage concentric-ring-type fuel cartridge. The formulation and coding of this problem was set up for air as the fluid being heated. With slight modifications, however, the program may be adapted to treat any other compressible gas. (auth)

**32289** (APEX-640) TEMPERATURE DISTRIBUTION IN A CYLINDRICAL SOLID WITH SYMMETRICALLY-PLACED LONGITUDINAL COOLANT CHANNELS. J. F. Heyda and R. C. Herrmann (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Apr. 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 74p.

A right circular cylindrical solid containing a uniformly-distributed heat source has a central coolant channel and k symmetrically-placed off-center coolant channels; in addition its curved surface is surrounded by a solid annular ring, also containing a uniform heat source, with an insulated outer surface. The temperature fields in the cylinder and ring were determined analytically and an IBM 7090 computer program for their numerical evaluation is presented. (auth)

**32290** (APEX-754) PRESSURE LOSS COMPUTATIONS IN INCOMPRESSIBLE FLUID FLOW. J. L. Hobbs (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). July 25, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 45p.

The electrical analogy as applied to both series and parallel fluid flow circuits is described. The discussion covers the derivation and includes an example of each method. Information to be used in establishing loss coefficients for some of the more commonly used duct components is given. (auth)

**32291** (ARF-1167-15) FEASIBILITY STUDY OF A NEW MASS FLOW SYSTEM. Quarterly Report No. 5, June 1, 1961 to August 31, 1961. J. W. Haffner (Illinois

Inst. of Tech., Chicago. Armour Research Foundation). Sept. 20, 1961. Contract AT(11-1)-578. 35p.

With this is bound: Quarterly Report No. 15, Period June 1 to August 31, 1961. W. K. Genthe (Badger Meter Mfg. Co., Milwaukee). Prepared under Subcontract to AT(11-1)-578.

Activities are reported on development work on a mass flow system capable of measuring externally the properties of homogeneous flow, slurries, highly corrosive fluids, and multi-phase fluids. In the proposed system, the fluid passes through an S-shaped tube wherein measurements of angular momentum and density yield mass flow directly. (B.O.G.)

**32292** (AROD-1074.16) ENGINEERING PROPERTIES OF NON-NEWTONIAN FLUIDS. Final Report. A. B. Metzner (Delaware. Univ., Newark). Aug. 1961. Contract DA-36-034-ORD-1495-RD. 17p.

A review is given of the results achieved partly or wholly in the following areas: fluid mechanics, heat transfer, mass transfer, and theoretical rheology. (auth)

**32293** (IS-330) GASEOUS DIFFUSION AT MODERATE FLOW RATES IN CIRCULAR CONDUITS. George Roley and R. W. Fahien (Ames Lab., Ames, Iowa). July 1960. Contract W-7405-eng-82. 164p.

Mass transfer studies were made for an air-carbon dioxide gas system flowing through a 4-inch cylindrical conduit at Reynolds numbers of 1500, 5000, and 10,000. Turbulent transport mechanisms were investigated in order that basic theory in this area be expanded. The experimental technique consisted of introducing a carbon dioxide tracer into the center of a moving air stream and determining concentration and velocity distributions at various downstream positions. Gas samples were removed by means of a pitot tube and analyzed by a thermal conductivity cell. A circular five-loop hot-wire anemometer was used to establish the velocity profiles. A dual treatment of the data was provided by fitting the concentration and velocity distributions to two solutions of the basic diffusion equation,  $(\partial/\partial r)[E_r r(\partial C/\partial r)] = r(\partial/\partial z)[C_u - E_a(\partial C/\partial z)]$ . Certain discrepancies arose in both solutions because of different simplifying assumptions used. These factors are pointed out while considerable attention is devoted to theoretical explanations of features exhibited by the results. Point and average values of total diffusivity, mass transfer Peclet number, and eddy viscosity were determined for the diffusion of carbon dioxide in air. Mass and momentum transfer analogies are illustrated by comparing the dimensionless groups of Peclet number to Schmidt number and eddy mass diffusivity to eddy momentum diffusivity. Equations were derived to enable the importance of axial diffusion to be estimated. A characteristic diffusivity was defined which permits a general correlation of total diffusivity with both position and flow rate. (auth)

**32294** (K-1487) BOILING OF FREON-114 IN A THREE-FOOT STRAIGHT TUBE EVAPORATOR. Charles F. Allen (Oak Ridge Gaseous Diffusion Plant, Tenn.). Oct. 19, 1961. Contract W-7405-Eng-26. 21p.

Experimental determinations of heat flux were made with Freon-114 flowing by natural circulation through a steam-heated vertical tube with and without swirl promoters. The heated length of the  $7/8$ -inch outside diameter copper tube was 35 inches, the saturation temperature of Freon-114 at test-section flow exit 160°F, and the heat flux range from 7,000 to 70,000 Btu/hr/sq ft. Heat flux measurements at specified conditions were compared to determine the degree of fouling and the effect of swirling flow on heat transfer efficiency. Experimental data showed that the circula-



tion of water-saturated Freon-114 at 200°F for 2½ hours did not produce sufficient steel corrosion products to foul the surface of the evaporator. Swirl promoters were effective in reducing dry-wall vapor binding at the higher heat loads. The 50% increase in maximum heat flux observed was limited by the low liquid-to-vapor ratio of the bulk Freon leaving the evaporator. An increase in input flow to the evaporator by forced circulation or increased liquid heat should produce an additional increase in maximum heat flux. (auth)

**32295** (KAPL-M-RAH-3) TRANSIENT FREE CONVECTION IN A VERTICAL ANNULUS SURROUNDED BY A THICK-WALLED CYLINDER. R. A. Heffley and T. J. Smith (Knolls Atomic Power Lab., Schenectady, N. Y.). June 9, 1961. Contract W-31-109-eng-52. 26p.

A simplified analysis is made of transient free convective heat flow in a long vertical annulus surrounded by a thick-walled cylinder. The particular application to the determination of axial temperature distributions in a reactor pressure vessel head penetrated by narrow annuli is discussed. Pressure drop and energy balances are written for the fluid traversing the convection loop, allowing specification of the boundary conditions at the annular surface for quasi-steady state conditions. (auth)

**32296** MEASUREMENT OF HEAT TRANSFER IN A GRAPHITE ROD HEAT EXCHANGER. Charles B. Johnson and Frank L. Clark (NASA Langley Research Center, Langley Field, Va.). ARS (Am. Rocket Soc.) J., 31: 1458-60 (Oct. 1961).

Some preliminary results obtained during the operation of a high pressure, high temperature induction type heat exchanger capable of sustained operation are presented in graphical and tabulated form. The major components of the heat exchanger consist of a high pressure stainless steel chamber, water cooled induction coil, and graphite heater element. Nitrogen was used as the flow medium. The graphite surface temperature  $T_s$  was measured for a number of mass flows with an optical pyrometer. The entrance temperature was found by keeping the gas from flowing through the hot graphite element and then measuring the exit gas temperature. The entrance temperature thus determined and the exit temperature with the hot graphite element in the heating cycle were then used to calculate the amount of energy absorbed as the gas passed through the graphite element. (P.C.H.)

**32297** MOTION OF A VISCOUS COMPRESSIBLE GAS ADJACENT TO A SLIDING PLATE. Francis H. Harlow and Billy D. Meixner (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 4: 1202-6 (Oct. 1961).

Numerical calculations were made of the motion of a viscous compressible gas adjacent to a flat plate moving rapidly in its own plane. The analytical solutions given by Stewartson were checked and good agreement obtained after a slight modification was made in the results of his solution-matching technique. The computer results illustrate the detailed flow profiles which should be useful in the generation of improved analytical solutions. In addition, computations were performed to show the effects of variations of Prandtl number, viscosity ratio, and plate acceleration history. (auth)

**32298** HEAT, MASS, AND MOMENTUM TRANSFER. Warren M. Rohsenow and Harry Y. Choi. Prentice-Hall Series in Engineering of the Physical Sciences. Englewood Cliffs, New Jersey, Prentice-Hall, Inc., 1961. 558p. \$16.00.

A parallel, unified treatment is presented of the transfer

of momentum, heat, and mass. This parallel treatment emphasizes the similarity of the governing equations and at the same time indicates their areas of dissimilarity. Theoretical methods are developed in a series of problems and validated by experimental results. Boundary-layer concepts are introduced and stressed as major concepts in the analysis of transfer processes at solid-fluid interfaces. Results are presented from direct solutions of the differential equations and from the Karman-Pohlhausen integral method for the boundary-layer concepts. The treatment of radiation includes heat transfer between surfaces, employing electrical analog methods and extends to gaseous radiation effects. The spectral energy distribution is derived by the method of statistical mechanics. Important areas of application such as boiling and condensation and high speed and high altitude flight are considered in depth. Developments in heat transfer such as liquid metals, ablation, magnetic effects, anisotropic materials, and heat transfer in reactors are also discussed. Dimensional analysis, numerical analysis, or finite difference methods, and analogs are presented. The methods of irreversible thermodynamics for analyzing coupled transfer processes and the kinetic theory interpretation of transport properties are also presented. (N.W.R.)

**32299** IMPROVEMENTS RELATING TO EVAPORATING INSTALLATIONS. (to Société Française des Constructions Babcock & Wilcox). French Patent 1,205,952. Feb. 5, 1960.

The evaporating installation comprises at least one evaporating tube bundle placed inside a casing through which the heating fluid, such as a gas, circulates. The tube bundle is in communication with a liquid-steam separating chamber positioned outside this casing. Each of these bundles of nearly vertical tubes comprises a lower water entrance header and an upper vapor exit header, each being individually connected to the separating chamber outside the casing. The flow in these tube bundles is induced by natural circulation. The lower water entrance header is fed by a tube passing through the upper header and through a central tube of the bundle and reaching finally with its open end into the lower header. The outer diameter of this feed tube is smaller than the inner diameter of the central tube in order to form around the feed tube a skirt of evaporating fluid. (NPO)

**32300** HEAT EXCHANGER CONSTITUTED BY A COMBINATION OF ELEMENTS EACH HAVING A PLATE FORM. (to Chantiers de Atlantique). French Patent 1,215,858. Apr. 21, 1960.

In order to provide a completely leak-proof circuit for heavy water used as coolant in a reactor and passing as heating fluid through a heat exchanger, the heat exchanger comprises a multitude of heat exchange elements, each formed by simultaneously rolling two metal sheets together (roll-bonding) except at the areas which are to define the fluid circulating path; these areas are provided with a layer which prevents welding. The coolant channels are formed by expanding the sheets hydraulically at these areas. Each element contains parallel channels connecting a pair of headers. The elements are rectangular and are arranged with their headers and their inlet and outlet tubes in contact, the tubes being on the same side of the element. The heavy water flows through these elements, which are connected in parallel, while ordinary water circulates outside between these elements. In each element the cooling channels are grouped and connected in such a way that channels of one group are in parallel and successive groups are in series. (NPO)

**32301** IMPROVEMENTS RELATING TO HEAT EXCHANGERS AND BOILERS. (to Clarke, Chapman & Co. Ltd.). French Patent 1,222,021. June 7, 1960.

The heat exchanger comprises a plurality of ducts parallelly positioned and connected at the ends by headers. Each duct encloses at least one helical coil tube, the helical axis is aligned with the duct axis and the ends of this coil tube passes directly through the wall of the duct. In another form one end of each coil tube passes directly through the duct wall, while the other is connected to the end of a tube that passes axially back through the coil and then directly through the duct wall. The ducts are formed by tubular pieces welded together in such a way that each coil end is held in place by two adjacent tubular pieces, which are provided at the ends with semi-circular slots for this purpose. (NPO)

**32302** METHOD OF HEAT TRANSFER BY MEANS OF ORGANIC LIQUIDS. (to Shell Internationale Research Maatschappij N. V.). French Patent 1,234,554. May 16, 1960.

The reactor coolant consists of 1,3,5-triphenyl benzene (m.p. 174°C, b.p. 460°C), its mixtures with terphenyl, biphenyl, isopropyl biphenyl, or aromatic petroleum extracts having a b.p. of 350 to 400°C, or its entectic mixtures with lower alkyl derivatives of 1,3,5-triphenylbenzene. (NPO)

**32303** ELECTRICAL DEVICE FOR IMPROVING THE HEAT EXCHANGE IN A BOILING DIELECTRIC LIQUID. (to Commissariat à l'Energie Atomique). French Patent 1,236,061. June 7, 1960.

For improving heat exchange in a boiling dielectric liquid, both in the film and nucleate boiling region, and avoiding burnout phenomena an electric field is created in the proximity of the heat exchange surfaces. This field may be continuous, modulated, or alternating and is set up between an auxiliary electrode and the heat exchange surface, the electrode and surface being held at different electric potentials. The boiling liquid is one that can be boiled without appreciable decomposition, e.g., benzene, toluene,  $\text{CCl}_4$ , polyphenyl, or a liquefied gas. (NPO)

## Instrumentation

**32304** (AERE-R-3078) THE NITROUS OXIDE RADIATION DOSIMETER AND ITS APPLICATION TO THE EVALUATION OF FISSION FRAGMENT ENERGY DEPOSITION. F. Moseley and A. E. Truswell (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Jan. 1960. 43p.

The decomposition of nitrous oxide induced by pile ny and fission fragment radiations was examined over a range of percentage conversions and gas pressures. The data obtained were compared with previous results both for these and other types of ionizing radiation. The conditions under which nitrous oxide can be used as a radiation dosimeter are stated. The dosimeter was used to investigate the efficiency with which fission fragment energy generated in solid sources of various kinds can be transmitted to a surrounding gas. Three such sources were examined: thin films of uranium metal, thin films of  $\text{U}_3\text{O}_8$  on platinum backings, and  $\text{U}_3\text{O}_8$  dispersed in the pores of active charcoal. Previous mathematical computations of the fraction of energy emerging from the first two sources are shown to be substantially correct. Chemical reaction between nitrous oxide and active charcoal makes the dosimeter unreliable for use with the third source. (auth)

**32305** (AFSWC-TR-61-57) SOLID STATE JUNCTION FAST NEUTRON SPECTROMETERS. R. V. Babcock (Westinghouse Electric Corp. Materials Labs., East Pittsburgh, Penna.). Includes Appendices: I. INITIAL CONCEPTS OF P-N JUNCTION FAST NEUTRON SPECTROMETERS. II. ARTIFICIAL CROSS SECTIONS FOR THRESHOLD DETECTORS. J. D. Reichert and S. L. Ruby. III. FAST NEUTRON DAMAGE TO SILICON JUNCTION PARTICLE DETECTORS. Aug. 1961. 111p.

Possible fast neutron spectroscopy systems using P-N junctions were investigated. Combinations of fast fission threshold counters exhibited useful energy dependencies. As part of this evaluation, fission cross sections of  $\text{Th}^{232}$  and  $\text{U}^{234}$  in the 12 to 18 Mev range were measured.  $\text{Li}^6\text{F}$  spectrometers exhibited excellent energy resolution. To extend their value, the  $\text{Li}^6(n,\alpha)\text{H}^3$  cross section was measured in the range 0.75 to 1.65 Mev. A carbon recoil method for large neutron fluxes also showed promise. A system using the  $\text{Li}^6\text{F}$  device in the range 0 to 8 Mev and carbon recoil at higher energies is recommended. Where less resolution is needed the fast fission system is more sensitive. (auth)

**32306** (APEX-639) THE DEVELOPMENT OF A FAST NEUTRON SPECTROMETER USING SILICON SURFACE BARRIER DIODES. J. J. Baum (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). May 25, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 39p.

A general review of the current state-of-the art in semiconductor nuclear detectors is presented. Fabrication of a silicon surface barrier diode for a fast neutron spectrometer is described and a direction for future developments in this field is indicated. (auth)

**32307** (APEX-711) CURRENT STATUS OF THE AC IONIZATION CHAMBER. G. K. Rusch (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). July 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 15p.

The design concept of an a-c ionization chamber and its supporting electronics is described. Several designs are possible and the sensors can be tailored to specific requirements when necessary. Mode of operation, signal voltage development, and switching frequency are discussed. High-sensitivity operation is described. Requirements for high-temperature, power-level operation are outlined. (M.C.G.)

**32308** (DP-618) A RECORDING POLAROGRAPH FOR ROUTINE ANALYSES. Robert C. Propst (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Aug. 1961. Contract AT(07-2)-1. 12p.

A recording polarograph is described that is compact, simple to operate, and well suited for routine analyses. The coefficient of variation of current measurements indicated by the recorder was 0.35%. When the polarograph was used for the routine determination of uranium in about 0.1M uranyl nitrate, the coefficient of variation was 1.1%. (auth)

**32309** (IFA/M-20) POLE FACE SHAPE CALCULATION FOR WEAK FOCUSING NUCLEAR INSTRUMENTS. C. C. Iliescu (Academia R. P. R. Institutul de Fizica Atomica, Bucharest). 1961. 12p.

Formulas are presented for calculating pole face shapes for inhomogeneous magnetic fields in weak magnetic focusing nuclear instruments. Infinite permeability of the pole piece material is assumed and the effect of finite extension in the radial direction is neglected. The formulas are applied to several examples. (D.L.C.)



**32310** (JPL-TR-32-105) EFFICIENCY OF FISSION ELECTRIC CELLS. Clifford J. Heindl (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). May 25, 1961. Contract NASw-6. 32p.

Electrical efficiencies are calculated for fission electric cells of parallel plate, concentric sphere, and concentric cylinder geometries as a function of operating voltage and fuel layer thickness. For spherical and cylindrical cells, several ratios of outer to inner radii are included, covering the range which appears feasible for a reactor which is to be carried on a spacecraft. The calculations are simplified by ignoring the distribution of fission fragment masses, charges, and kinetic energies and utilizing average values for these quantities; a linear rate of energy loss is assumed for the first portion of the fragment trajectories, as they pass through the fuel layer. The calculated efficiencies decrease with fuel layer thickness, increase with the curvature of the electrodes and ratio of outer to inner electrode radii, and exhibit a maximum at operating voltages near one-half of maximum achievable potential. (auth)

**32311** (NP-10831) NEUTRONICS SYSTEMS FOR NUCLEAR ROCKET ENGINE TESTING. Allan R. Gunion and Ray Winn (Edgerton, Germeshausen and Grier, Inc., Boston). [1961]. 34p.

Paper No. 2120-61 for presentation at American Rocket Society, Space Flight Report to the Nation/New York Coliseum, October 9-15, 1961.

The Nuclear Instrumentation System used by Project Rover is discussed. Ion chambers and a water tank attenuator are arranged for a wide dynamic range. Logarithmic and self-ranging linear amplifiers are used in an over-all system to cover eleven decades. Power level and period signals are used for closed loop reactor power control and automatic scram circuitry. Redundancy for increased reliability and accuracy is discussed. (auth)

**32312** (ORNL-3058) PERSONAL RADIATION MONITOR. R. H. Dilworth and C. J. Borkowski (Oak Ridge National Lab., Tenn.). Oct. 18, 1961. Contract W-7405-eng-26. 24p.

A Personal Radiation Monitor instrument was developed that weighs  $3\frac{1}{2}$  ounces and has the size of an ordinary fountain pen. Worn in the pocket of the user, the device provides immediate audible and visual indication of gamma dose rate. Indications are given by the simultaneous flash of a neon lamp and a burst of audible warning tone best described as a chirp. The repetition rate of the chirp and flash is proportional to gamma dose rate. The proportional range of indication extends from background to about 2 r/hr for instruments set to the normal range of sensitivity. An optional less sensitive range extends the upper limit of proportional indication to 200 r/hr. In either range the maximum indications do not block in overloading radiation fields short of that which would damage the components. To insure continuous protection, there is no on-off switch. Operation for one month is obtained from a four volt mercury battery. The instrument uses a miniature halogen filled Geiger counter as the radiation detector. Generation of 500 volts to operate the counter is done by a transistor blocking oscillator, transformer, and semiconductor diode voltage quadrupler. Feedback through two transistor emitter followers increases the rate of the oscillator in proportion to Geiger tube current, and a fourth transistor amplifies this tone into a hearing aid earphone with resonant air column. The electronic assembly is encapsulated in epoxy resin for protection and housed in a tubular stainless steel case fitted with a pocket clip. (auth)

**32313** (SCTM-181-61(14)) A PULSE AMMETER. J. J. Newman (Sandia Corp., Albuquerque, N. Mex.). Aug. 1961. Reprinted Oct. 1961. Contract [AT(29-1)-789]. 13p.

A quantizing pulse ammeter was designed which brackets an input pulse current peak between two preset current levels. These levels are easily selected by calibration circuits contained on the chassis. Readout is presented in the form of a Nixie visual display as well as an output which is suitable for automatic data recording. (auth)

**32314** (TID-13308) FINAL REPORT, PHASE III OF THE NUCLEAR MATERIALS CONTROL SYSTEM. D. L. Drukey (Ramo-Wooldridge. Div. of Thompson Ramo Wooldridge Inc., Canoga Park, Calif.). Dec. 31, 1960. Contract AT(04-3)-165. 87p.

The operations in a typical nuclear complex, such as might be implemented overseas, were analyzed and methods were derived for utilizing the results of measurements made in that complex, to insure that nuclear materials were not lost or diverted. The complex was assumed to consist of nine reactors, a chemical reprocessing plant, and fuel fabrication facilities. Decision functions, mathematical expressions into which the results of measurements may be inserted to determine whether or not a loss has occurred, were derived. Scaling rules were formulated to modify the decision functions for different attainable precisions of analysis. The recommended procedure for using instrument calibration measurements is outlined. The decision areas and the individual false alarm interval associated with each area are listed. (M.C.G.)

**32315** (TID-13865) ENGINEERING MODEL OF A PARTIAL SWITCHING EFFECT IN FERRITE CORES. Report No. 111. Sylvian R. Ray (Illinois. Univ., Urbana. Digital Computer Lab.). Sept. 5, 1961. Contract [AT(11-1)-415]. 83p.

A model of the partial switching effect (flux reversal proceeding from an initially unsaturated state) in magnetic core materials is constructed on the basis of physically rational microscopic switching processes. Attention is focused on a particular type of partial switching in which the intermediate state is reached by a mmf pulse in the "UP" (set) direction, and the response to a pulse in the "DOWN" (reset) direction is examined. (D.L.C.)

**32316** (TID-13949) THE CHanneled IMAGE INTENSIFIER. Final Report, March 1960 through August 1961. (Chicago. Univ. Labs. for Applied Science). Contract AT(11-1)-647. 48p. (LAS-TR-P150-13)

Design of a channeled intensifier is described. Each component is described in detail, both in regard to fabrication and in regard to processing by procedures currently used. A summary of activities during the development program is included and the technical problems that remain to be solved before the channeled intensifier can be produced in practical form are examined. (J.R.D.)

**32317** (UCLA-484) COUNTING OF  $\alpha$ - AND  $\beta$ -RADIATIONS IN AQUEOUS SOLUTIONS BY THE DETERGENT-ANTHRACENE SCINTILLATION METHOD. L. S. Myers, Jr. and A. H. Brush (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). July 28, 1961. Contract AT-04-1-GEN-12. 25p.

The use of a two-phase solution-detergent-anthracene system as a general method for counting  $\alpha$  and  $\beta$  radiation in aqueous solutions is proposed. The method consists of pipetting the radioactive solution onto detergent-coated anthracene in a vial and counting in a liquid scintillation

counter. Solutes in up to one molar concentration do not interfere, and hence nearly all sample preparation steps can be eliminated. Inherent counting efficiencies are sufficiently high that, except for  $H^3$ , simple unrefrigerated counting equipment can be used. A tendency for the detergent to foam and sorption of the isotope onto the anthracene may influence results under certain conditions. (auth)

**32318** (UCRL-5409) HIGH TEMPERATURE PRODUCTION AND MEASUREMENT—A BIBLIOGRAPHY. Frederick E. Frost, comp. (California. Univ., Livermore. Lawrence Radiation Lab.). Nov. 10, 1958. Contract W-7405-eng-48. 9p.

A survey was made of literature published from 1950 to 1958 on the production and measurement of high temperatures (2000 to 3000°F). The 74 references are arranged by reports, books, and journals. Within these three groupings arrangement is by report number or by personal author in the book and journal sections. (M.C.G.)

**32319** (UCRL-9765) AN ALPHA AIR PROPORTIONAL HAND AND FOOT COUNTER. William J. Roach and Robert J. Walker (California. Univ., Berkeley. Lawrence Radiation Lab.). July 14, 1961. Contract W-7405-eng-48. 9p.

A transistorized alpha air proportional hand-and-foot counter was developed. Field use for one year shows that low maintenance, low cost, and reliability are obtainable with air proportional detectors. (auth)

**32320** (UCRL-9789) RESPONSE OF THE OAK RIDGE CRITICALITY FISSION FOIL MONITOR. Bob Wayland (California. Univ., Berkeley. Lawrence Radiation Lab.). July 17, 1961. Contract W-7405-eng-48. 19p.

The Oak Ridge criticality fission foil monitor was tested for response to photofission and the possibility of photofissions "masking" the neutron response. For radiation of energy less than 5 Mev, the response to neutrons will not be masked by the gammas. For energies greater than 5 Mev, the response to neutrons may be "masked" by photons if the abundance of photons is  $10^3$  as great as the neutrons. (auth)

**32321** (USNRDL-TR-523) THE RGI-20 RADIAC SYSTEM—A WIDE-RANGE BETA-GAMMA INSTRUMENT. PART I. SURVEY METER SKIN-DOSE PROBE. K. Miller and G. T. Kiyoi (Naval Radiological Defense Lab., San Francisco). Sept. 7, 1961. 33p.

A wide-range, multipurpose radiac of 20% accuracy was developed for tactical military use. The instrument consists of a 2.5-lb, belt-carried package which measures  $\gamma$  rate in three ranges to 1,000 rad/hr, and a plug-in probe to read skin-dose rate ( $\beta + \gamma$ ) to 5,000 rad/hr. Provision is made to connect a four-decade low range probe now under development, or to connect other special purpose detectors remote from the meter. The RGI-20 incorporates several other features unusual in Navy radiacs: a recycling ion chamber and low-impedance circuitry, a simplified scale-changing mechanism capable of switching 11 linear scales, and rechargeable batteries. Construction and performance information are included. (auth)

**32322** (NP-tr-749) SHIELDING A GYROSTABILIZER WHICH IS A SOURCE OF ELECTROMAGNETIC INTERFERENCE. E. (Ye.) I. Shelepin, K. M. Sobolevskii (Sobolevskiy), and V. S. Baranetskii (Barenetskii). Translated from *Avtomat. Kontrol' i Izmeritel'. Tekh.*, No. 4, 102-8 (1960). 9p.

A metal shield casing was designed to shield an electrical gyrostabilizer and thus reduce its electromagnetic interference with a receiving-sensing device to  $\leq 10 \mu v$  ( $3 \times 10^{-8}$  gauss). The efficiency of the shield was measured

at various operating frequencies of the measuring device. (D.L.C.)

**32323** (UCRL-Trans-682) RADIOMETER FOR MEASURING IODINE-131 IN THE HUMAN THYROID GLAND. A translation of "Radiometr dlya Izmereniya Ioda-131 v Shchitovidnoi Zheleze Cheloveka." V. A. Bryzgunov (Akademiiya Nauk S.S.S.R. Ordena Lenina Institut Atomnoi Energii). 1960. 11p.

Design features are described of an apparatus developed for measuring  $I^{131}$  in the thyroid gland. Gamma radiation formed during the decay of  $I^{131}$  is measured with a shielded scintillation detector with a small photomultiplier. The recording part of the apparatus is mounted separately. A wiring diagram, schematic sketch, and calibration data are presented. (C.H.)

**32324** HIGH TEMPERATURE FISSION CHAMBERS AND IONIZATION CHAMBERS. G. M. B. Bouricius (General Electric Co., Cincinnati). *ARS (Am Rocket Soc.) J.*, 31: 1439-41 (Oct. 1961).

A 700°C fission chamber built and tested showed the counting rate to decrease as the temperature increased from 30 to 700°C. The noise level shows no increase. The cause of the decrease in counting rate is under investigation, and it is the associated electronic circuitry that is suspect. Experimental current integrating type ionization chambers were built and tested to 350°C. The background current increases with temperature, being about  $3 \times 10^{-8}$  amp at 350°C. Experimental a-c ionization chambers, which were built and tested, show no adverse effects caused by background d-c leakage current. These are being readied for test at elevated temperatures. (auth)

**32325** AN AUTOMATIC ISODOSE RECORDER. W. R. Beasley, A. W. Melville, and R. N. Knight (Dept. of Scientific and Industrial Research, Auckland, N. Z.). *Brit. J. Radiol.*, 34: 648-54 (Oct. 1961).

An instrument was devised which is capable of plotting automatically and without approximation, the dose distribution in radiation fields of any configuration, gradient, or polarity. The plotting technique is believed to be novel and in one scan of the field any reasonable number of curves may be plotted, the information being presented on graph paper as dots which are subsequently joined to form isodose curves. The positioning accuracy is better than  $\pm 0.5$  mm, while the reproducibility of the servo-balancing system is better than  $\pm 1/2\%$ . (auth)

**32326** ETL TYPE MASS SPECTROMETER. Yajiro Inoue and Kogoro Maeda. *Denki Shikensho Ihō*, 25: 521-8 (July 1961). (In Japanese)

A large type of mass spectrometer was designed and constructed for the purpose of analyzing impurities in a standard sample of radioactivity. The apparatus is of a single focussing type with 90° magnetic sector field, and the radius of ion beam is 80 cm. Some other specifications in designing the spectrometer are as follows: ion accelerating voltage, maximum 30 kv; accelerating voltage of bombarding electron, 60 to 100 v; field of analyzer magnet, 0 to 6,000 gauss; scanning, magnetic; ion-beam detecting system, 100% feed back d-c amplifier and high speed pen recorder; evacuating system, two 3" diffusion pumps with nitrogen cold traps. Several tests on the apparatus were made with three rare gases (neon, xenon, and krypton) and two hydrocarbons (propane and n-butane). The resolving power obtained from these tests was about 600 to 650. A further test with mixture of carbon dioxide and propane gases was made to ascertain the result. (auth)

**32327** RESOLUTION AS A FUNCTION OF NOISE SPECTRUM IN AMPLIFIERS FOR PARTICLE DETEC-



TION. E. Gatti (Istituto di Fisica del Politecnico, Cattedra di Elettrotecnica nucleare, Milan) and V. Svelto. *Energia nucleare* (Milan), 8: 505-9 (Aug. 1961). (In English)

The optimum signal-to-noise ratio  $\eta_{\infty}$  for charge amplifiers is calculated for a noise power spectrum of a quite general shape; this ratio may be applied to amplifiers for semiconductor detectors. For a practical shaping network of the amplifier (two differentiating and two integrating time constants), the actual signal-to-noise ratio  $\eta$  is calculated. It is possible, from the knowledge of the noise spectrum, to choose the best time constants and to calculate  $\eta$  and  $\eta_{\infty}$ ; therefore, it is possible to evaluate how much is lost utilizing ( $\eta$  against  $\eta_{\infty}$ ) the information from the detector. (auth)

**32328** THE LIGHT CHAMBER: A "LINEAR" DISCHARGE CHAMBER. SOME FURTHER DEVELOPMENT. F. T. Arecchi (CISE, [Milan]), G. Cavalleri, E. Gatti, and G. Redaelli. *Energia nucleare* (Milan), 8: 539-40 (Aug. 1961). (In English)

The brilliance and narrowness of the tracks in a linear discharge chamber (light chamber) can be improved by driving the electrons of the ionized track through an a-c electric field instead of a d-c field. If a damped oscillation is substituted to an exponential voltage pulse, the electrons will bounce back and forth following the quasi-periodic force, instead of drifting, in a unique sense for all the duration of the excitation. (N.W.R.)

**32329** DETERMINING NEUTRON ENERGY DISTRIBUTION. R. S. Hall (The University, Birmingham, Eng.). *Engineering*, 192: 416-17 (Sept. 29, 1961).

A review is given of some of the methods used for determining the neutron energy distribution from various sources. The methods and equipment reviewed are: mechanical shutter, rotating chopper, pulsed neutron source, crystal diffraction, neutron-absorbing foil, and threshold detectors. (N.W.R.)

**32330** A THIN PLASTIC RADIATION DOSIMETER. K. K. Harris and W. E. Price (Lockheed Missiles and Space Div., Palo Alto, Calif.). *Intern. J. Appl. Radiation and Isotopes*, 11: 114-22 (Sept. 1961). (In English)

Because of their very short range, radiation doses of low-energy particles and x rays are difficult to measure by the usual methods. To perfect a dosimeter to measure low-energy radiation doses, the change in optical transmission of thin plastic films was studied as a function of dose. A survey of twenty types of film placed in  $\gamma$ -radiation fields up to  $10^7$  r was made. Saran No. 7 was found to have the most suitable characteristics. Optical densities of Saran at 2600 Å vs. exposure dose was found to be a straight line on a log-log plot from  $5 \times 10^4$  r to  $10^7$  r when irradiated by  $\gamma$ -radiation. A dose of  $10^4$  r was detectable and the range may extend above  $10^7$  r. The change in absorption of Saran caused by radiation is only slightly reduced when irradiated in vacuum and measured in an inert atmosphere. (auth)

**32331** CELLULOSE AS A RADIATION DOSIMETER. R. C. L. Bosworth, I. Ernst, and J. L. Garnett (Univ. of New South Wales, Sydney). *Intern. J. Appl. Radiation and Isotopes*, 11: 152-4 (Sept. 1961). (In English)

It was found that cellulose, when irradiated with  $\gamma$ -rays to exposure doses in the range  $10^{6.25}$ – $10^{8.0}$  rads and then treated with aqueous sodium hydroxide, yielded an appreciable yellow color reaction, the intensity of which was directly proportional to the dose. The experimental results indicate that this system has a potential value in chemical dosimetry. When sheets of purified cellulose (chromatog-

raphy paper) were irradiated, the technique yielded a visual spot-test dosimeter which is simple, cheap, rapid, and accurate to  $10^{0.25}$ . Quantitative data can be obtained to within 2 per cent using a spectrophotometric procedure. (auth)

**32332** AN INEXPENSIVE DISPOSABLE SAMPLE CONTAINER FOR SINGLE PHOTOTUBE LIQUID SCINTILLATION COUNTING. K. H. Kimbel and J. Willenbrink (Research Labs., Schering A.G., Berlin). *Intern. J. Appl. Radiation and Isotopes*, 11: 157 (Sept. 1961). (In English)

The use of a semi-transparent polyethylene container for single phototube liquid scintillation counting is recommended because of a reduction of background, unbreakability, low costs and disposability. (auth)

**32333** CALIBRATION OF A MONITOR FOR USE IN BREMSSTRAHLUNG BEAMS. E. G. Fuller and Evans Hayward. *J. Research Natl. Bur. Standards*, 65A: 401-4 (Sept.-Oct. 1961).

The calibration of a thick-walled ionization chamber by means of a sodium iodide scintillation spectrometer is described. The calibration was made for six bremsstrahlung energies in the range 6 to 19 Mev. (auth)

**32334** STRUCTURE AND MANNER OF OPERATION OF RATE-METER CIRCUITS. J. Carlebach (Abteilung Strahlenschutz der Kernforschungsanlage, Jülich, Ger.). *Kerntechnik*, 3: 405-7 (Sept. 1961). (In German)

A survey is given on the principal structure of ratemeter circuits. After a description of the function of the individual steps, important instructions for the dimensioning of the circuit are given. (auth)

**32335** NUCLEAR TRAINING AND RESEARCH EQUIPMENT. PART I. REACTOR SIMULATORS. Otto J. Joklik. *Nuclear Energy*, 291-5 (July 1961).

Any thermal or fast fission reactor, running at low power, can be simulated continuously up to 100 kw. Various configurations of fuel and moderator with the associated range of neutron lifetimes may be represented. The six groups of delayed neutrons associated with the fuels uranium-235, 233, or plutonium-239 can be reproduced. An additional simplified fuel, uranium-235/2, illustrates a two group treatment of delayed neutron effects and emphasizes the effect of delayed neutrons on reactor control. Provision for the study of the effectiveness of automatic control systems and the calculation of changes in reactivity due to fission product poisoning, temperature coefficient, and thermal transient effects can be incorporated to suit any requirement. The instrumentation provides all the important indications given on the control desk of a full size reactor. These include a pen recorder giving power indications on one logarithmic and four linear ranges: a doubling time meter and a logarithmic power meter. Shut-off rod and control rod positions are indicated and warning lights show conditions and rod limit positions. A recessed panel is provided to pre-set the initial conditions of the various fuels to be employed. The range of equipment can be used to supplement lectures on reactor kinetics and courses can be designed around this versatile facility. A fully comprehensive training program for potential reactor operators can be conducted with a simulator and a core model. (auth)

**32336** THE SEMICONDUCTOR SURFACE BARRIER FOR NUCLEAR PARTICLE DETECTION. G. Dearnaley and A. B. Whitehead (Atomic Energy Research Establishment, Harwell, Berks, Eng.). *Nuclear Instr. & Methods*, 12: 205-26 (July 1961). (In English)

A simple and reliable technique for the preparation of

surface barrier detectors in silicon and germanium is described. The performance and electronic requirements of these detectors are discussed and compared with those of diffused junction counters. Many properties of semiconductor detectors are of great value in nuclear physics and an outline is given of their advantages and limitations. Some special configurations for fission studies,  $dE/dx$  counters, and neutron detection are described. (auth)

**32337** METHODS FOR THE MEASUREMENT OF SUB-  
NANOSECOND LIFETIMES OF LOW-ENERGY NUCLEAR  
LEVELS. Ekbal Bashandy (Univ. of Uppsala). Nuclear  
Instr. & Methods, 12: 227-48(July 1961). (In English)

A review is given of methods available for the measurement of lifetimes of low-energy excited nuclear states. The review is limited to the nano- and sub-nanosecond region. Direct measurements by means of delayed coincidence technique, high frequency acceleration or deflection, direct timing, distance of flight, and recoil methods are discussed. In addition, certain related, indirect methods are considered. These are nuclear resonance scattering and absorption and Coulomb excitation. Finally, an evaluation of and comparison between the different methods is presented. (auth)

**32338** LEAKAGE CURRENT IN SEMICONDUCTOR  
JUNCTION RADIATION DETECTORS AND ITS INFLUENCE  
ON ENERGY-RESOLUTION CHARACTERISTICS. Fred S.  
Goulding and William L. Hansen (Univ. of California,  
Berkeley). Nuclear Instr. & Methods, 12: 249-62(July  
1961). (UCRL-9436) (In English)

The theoretical limits of noise in detector-amplifier combinations are discussed and related to the bulk properties of the semiconductor (lifetime and resistivity). A new detector structure which includes a guard ring as an integral part of the detector is described and its effect in eliminating surface leakage is discussed. Experimental results in good agreement with theory for detector leakage and noise resolution are presented. The residual surface effects not eliminated by the guard ring are shown to be important in very-low-leakage detectors, and the results of surface treatments to reduce these effects are briefly mentioned. Observations of the energy resolution of these detectors using various types of particles indicate that factors other than noise are important. Surface imperfections such as are encountered in polished surfaces may cause poor resolution when heavily ionizing particles are detected. Multiple peaks were also observed in  $\alpha$  spectra obtained with diffused junctions, possibly due to other surface effects. A brief description is given of the special electronic circuits used in these measurements. Techniques used in producing the guard-ring counter are described in detail. These employ gaseous diffusion to produce a thin surface junction, followed by etching through a photoresistant mask to produce the desired geometry. (auth)

**32339** A PAIR SPECTROMETER FOR ENERGIES UP  
TO 2 Bev. G. Bologna (C.N.E.N., Laboratori Nazionali,  
Frascati, Italy), G. Diambrini, R. Toschi, A. S. Figuera,  
U. Pellegrini, B. Rispoli, and A. Serra. Nuclear Instr. &  
Methods, 12: 263-77(July 1961). (In English)

A pair spectrometer, having the capacity of analyzing photon energies up to 2 Bev is described. Optical properties of the instrument are examined by calculating the horizontal and vertical deviation matrices. Magnetic measurements that were made both inside and outside the magnet gap in order to obtain information on the electron trajectories, are described. The method used in calculating the trajectories is given. The calculated trajectories are

compared with the ones obtained experimentally by means of the floating wire technique, a description of which is also given. Electronic devices used in the electron detection are described. (auth)

**32340** TRANSIT TIME OF CHARGE CARRIERS IN  
THE SEMICONDUCTOR IONIZATION CHAMBER. P. A.  
Tove and K. Falk (Univ. of Uppsala). Nuclear Instr. &  
Methods, 12: 278-90(July 1961). (In English)

Transit time of charge carriers and resulting pulse rise time are considered theoretically for a semiconductor particle detector, with particular reference to silicon detectors. Results are given in nomogram form for n- and p-type detectors, assuming constant mobility and specific ionization loss. The influence of various design factors is discussed, and the effect of non-constant mobility and ionization loss is calculated for typical cases. (auth)

**32341** PROTON RESONANCES SUITABLE TO SHAPE  
CALIBRATE A SCINTILLATION  $\gamma$ -RAY SPECTROMETER.  
Rolf Nordhagen (Universitetet, Oslo). Nuclear Instr. &  
Methods, 12: 291-8(July 1961). (In English)

A number of resonances in the reactions  $(p\gamma)$ ,  $(pp'\gamma)$  and  $(pa'\gamma)$  are found to yield monoenergetic  $\gamma$  rays with only small relative intensities of interfering radiations. The method by which these  $\gamma$  rays are used to provide *in situ* scintillation counter pulse-height distribution shapes for  $\gamma$  rays of arbitrary energy is described, and a detailed description of the resonance reactions and the  $\gamma$  rays they provide is given. The results of shape calibrating a 5 in. by 5 in. NaI scintillation counter are presented as an example. (auth)

**32342** A METHOD OF ALPHA PARTICLE SPECTROSCOPY  
FOR MATERIALS OF VERY LOW SPECIFIC ACTIVITY.  
C. R. Hill (Royal Cancer Hospital, London). Nuclear Instr. &  
Methods, 12: 299-306(July 1961). (In English)

A pulse ionization chamber technique was developed to identify the alpha radioactivity occurring as a natural constituent of many biological tissues and environmental materials. The chamber has a gridless, concentric cylindrical configuration, in which the 15,000  $\text{cm}^2$  source forms the outer electrode. Nuclides occurring in a material at a specific activity of a few tenths of a picocurie per gram can be identified and spectral line widths of the order of 150 kev are obtainable. (auth)

**32343** SOME TRANSISTOR CIRCUITS FOR NUCLEAR  
PHYSICS RESEARCH. R. Gabriel and A. M. Segar (Univ.  
of Chicago). Nuclear Instr. & Methods, 12: 307-15(July  
1961). (In English)

Useful transistor circuit modules are described, including coincidence and anticoincidence circuits, gating circuits, amplifying and pulse-shaping circuits, and a trigger circuit, all operating with resolution times of about  $10^{-8}$  sec. As examples of the use of these modules, a circuit for counting neutrons from muon-capture reactions is given and a circuit for discriminating neutrons from gamma rays by analysis of pulse shape. (auth)

**32344** AN IRON-FREE TOROIDAL  $\beta$ -SPECTROMETER  
WITH HIGH TRANSMISSION. N. A. Burgov, A. V. Davydov,  
and G. R. Kartashov (Inst. of Theoretical and Experimental  
Physics, Academy of Sciences, Moscow). Nuclear Instr. &  
Methods, 12: 316-22(July 1961). (In English)

An iron-free beta-spectrometer is described with transmission about 20% from  $4\pi$ . The main part of the spectrometer is a toroidal magnetic lense consisted of 810 turns. The maximum energy of the electrons to be focused



reaches 3.3 Mev, the current being about 130 amp. The theory of the instrument is given in some detail. (auth)

**32345** A 12 cm LIQUID DEUTERIUM BUBBLE CHAMBER. H. W. K. Hopkins, M. Davison, L. Lyons, J. M. Breare, D. Roaf, and D. F. Shaw (Clarendon Lab., Oxford). Nuclear Instr. & Methods, 12: 323-8(July 1961). (In English)

A bellows expanded bubble chamber, 12 cm in diameter, 9 cm deep, was designed for use with liquid deuterium. Good quality electron tracks were observed over the temperature range 31.2 to 34.1°K, with a minimum volume expansion ratio of 1.6%. It was used with the Harwell synchrocyclotron to study the interaction of 80 Mev protons with deuterons. The results are being analyzed with a modified rectangular coordinate plotter. (auth)

**32346** STABILIZATION OF THE COUNTING RATE BY IRRADIATION OF THE LIQUID SCINTILLATION COUNTING SOLUTIONS WITH UV-LIGHT. W. Lohmann and W. H. Perkins (Univ. of Arkansas and Consolidated Veterans Administration Hospital, Little Rock, Ark.). Nuclear Instr. & Methods, 12: 329-34(July 1961). (In English)

While counting certain compounds labeled with tritium or  $S^{35}$ , by liquid scintillation counting, it was observed that the counting rates decreased rapidly during the first 2 to 3 hours. Even after this time, the counting rates continued to decline, but at a slower rate. The influence of temperature, agitation of the vials, and addition of alcohol upon this phenomenon was investigated. In each case the counting rates decreased, except with additions of 2 ml or more of ethanol. All ethanol additions to the stock solutions produced a quenching of the counting rates. However, an irradiation of the stock solutions with UV-light of 2537 Å (Hg-line) stabilized the counting rates even without appearance of quenching. A possible theoretical explanation of these observations is given. (auth)

**32347** LOW JITTER PULSE DISCRIMINATOR AND SHAPER. M. Ageno (Istituto Superiore di Sanita, Rome). Nuclear Instr. & Methods, 12: 341-4(July 1961). (In English)

Conventional fast pulse discriminators and shapers give jitters of the order of 10 nanoseconds when the pulse amplitude just exceeds the threshold. In addition to this defect there are also variable delays, due to the discriminator level and pulse amplitude. A simple method whereby variable delays are practically removed by the introduction of a fixed delay is described. (auth)

**32348** FINITE GEOMETRY CORRECTIONS FOR ANGULAR CORRELATION MEASUREMENTS. D. J. Rowe, G. L. Salmon, and A. B. Clegg (Clarendon Lab., Oxford). Nuclear Instr. & Methods, 12: 353-4(July 1961). (In English)

A method is presented for calculating the smearing effect of counters of finite angular resolution, on angular correlation functions with azimuthal angle dependence. (auth)

**32349** A NEUTRON TIME-OF-FLIGHT SPECTROMETER WITH A SEMI-MONOCROMATIZING CHOPPER. S. Holmryd, K. E. Larsson, and K. Otnes (Aktiebolaget Atomenergi, Stockholm). Nuclear Instr. & Methods, 12: 355-61(July 1961). (In English)

A new type of slow chopper intended for use in neutron inelastic scattering measurements was constructed, which has a transmission curve much narrower than what is usual for slow choppers. This chopper is operated in conjunction with a beryllium filter to give a transmitted neu-

tron spectrum of a half value width of  $\approx 0.3$  Å at 4 Å which is a considerable improvement over the usual width of the cold neutron spectrum of more than 1 Å. The time resolution of the new instrument corresponds to 12  $\mu$ sec/m. A full description is given of the construction and operation of the instrument. (auth)

**32350** TOTAL CONVERSION COEFFICIENTS WITH A SUM-COINCIDENCE NaI SPECTROMETER. J. C. Vanderleeden and M. K. Ramaswamy (Ohio State Univ., Columbus). Nuclear Instr. & Methods, 12: 362(July 1961). (In English)

It is shown that total conversion coefficients ( $\alpha$ ) of  $\gamma$  rays can sometimes be determined using the sum-coincidence technique. The method derived is applicable only when the lifetime of the intermediate level is shorter than the decay time of the scintillator employed and is of advantage when the x rays are obscured in Compton scattering. (L.N.N.)

**32351** THE SCATTERING SURFACE METHOD OF MEASURING DISPERSION RELATIONS WITH A PHASED CHOPPER VELOCITY SELECTOR. R. E. Schmunk and R. M. Brugger (Phillips Petroleum Co., Idaho Falls, Idaho). Nuclear Instr. & Methods, 12: 365-6(July 1961). (In English)

The Materials Testing Reactor phased-chopper velocity selector was used to study single crystal coherent inelastic neutron scattering from beryllium. The experiment was directed toward obtaining the dispersion relations for the principal crystalline directions in beryllium. Transitions were observed in the desired directions by using the scattering surface methods described. The phased chopper velocity selectors portend great potential for studies of single crystal properties. (L.N.N.)

**32352** APPARATUS FOR REGISTRATION OF BETA RADIATION OF LOW INTENSITY, WITH CORRECTION FOR COSMIC RADIATION. Pall Theodorsson (to Atomenergikommissionen). British Patent 874,721. Aug. 10, 1961.

An anti-coincidence apparatus for counting low levels of beta radiation is designed which is inexpensive, simple to construct, and not bulky. The apparatus comprises two or more counter chambers of flat, shallow form. The advantage of the apparatus is its compact structure, which means that two or a few chambers are sufficient for a reliable anti-coincidence registration of mesons or other hard radiations. (D.L.C.)

**32353** IMPROVEMENTS RELATING TO THE DETECTION OF BURSTS IN FUEL ELEMENTS OF LIQUID COOLED NUCLEAR REACTORS. (to Commissariat à l'Energie Atomique). French Patent 1,211,512. Mar. 16, 1960.

In order to detect gaseous fission products coming from a burst fuel element, a washing gas is injected into the liquid coolant to strip the fission products. The washing gas entrains the fission products that are present in the coolant and, after being separated from the liquid coolant in a degasifier, conveys them to equipment for measuring their activity. (NPO)

**32354** DETECTOR FOR ESCAPES OF HEAVY OR LIGHT WATER FROM CIRCULATION SYSTEMS. (to ACF Industries, Inc.). French Patent 1,212,327. Mar. 23, 1960.

A detecting system is described that indicates escape of heavy or light water and consists in positioning, at the places where these escapes may occur, a first material impregnated with an indicating solution and covered with a second, preferably transparent material on the surfaces under inspection. The solution comprises ammonium chloride, bromocresol purple, Nacconol (sodium alkylaryl-

sulfonate) and alcohol. Between the two materials two conducting strips may be placed, one spaced from the other. Any escape of liquid causes a current between the two strips, convertible into an audible signal by an appropriate indicating device and a color change in the impregnated material. (NPO)

Materials Testing

**32355** (APEX-669) STRESSES IN HEXAGONAL TUBES. H. J. Kurtz and F. E. Wells (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Aug. 8, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 14p.

Stresses of hexagonal tubes when subjected to internal pressure without longitudinal restraint were investigated. The D/W ratios studied were 0.67, 0.728, 0.77, and 0.83. The test results indicated that maximum stresses occur on the inside circumference at the thickest part of the tube. (auth)

**32356** (KAPL-M-EC-10) BMS-STRESS ANALYSIS OF CYLINDRICAL SHELLS. D. G. Dight and R. F. Wojcieszak (Knolls Atomic Power Lab., Schenectady,

N. Y.). Aug. 1, 1961. Contract W-31-109-eng-52. 56p.

BMS is a digital computer program which utilizes finite difference procedures to calculate deflections, slopes and stresses along the length of a cylindrical shell or cone (whose apex angle is relatively small) resulting from any type of axi-symmetric loading. This also included thermal effects. With this program it is possible to analyze a shell with variable thickness, radius, and modulus of elasticity, whose end conditions are fixed, free, pinned or attached to another elastic structure. The program running time for one case should not exceed five minutes. (auth)

**32357** MEMORANDUM ON NON-DESTRUCTIVE METHODS FOR THE EXAMINATION OF WELDS. Ref. No.T29/1. London, British Welding Research Association, 1958 (Revised Edition)-1960 (Second Edition). 82p. 8s 6d.

Nondestructive testing methods are described and applied to welds and welded construction material. The methods described are: radiographic, ultrasonic and other acoustical, magnetic, penetrant, gas leak detection, proof and overload, and semi-destructive. The suitability of the methods for application to various welded joints is discussed. (N.W.R.)



# GEOLOGY, MINERALOGY, AND METEOROLOGY

**32358** (A/AC.82/G/L.614) UROVEN ZAGRYAZNE-NIYA PRIZEMNOGO SLOYA ATMOSFERY PRODUKTAMI ISPYTANII YADERNOGO ORUZHIIYA PO IZMERENIYAM V PODMOSKOV'E S 1955 PO 1959 G. (Level of Contamination of the Ground Layer of the Atmosphere by Products of Nuclear Weapons Tests, According to Measurements taken in the Moscow Area from 1955 to 1959). S. G. Malakhov (Akademiya Nauk S.S.S.R.). 1960. 39p.

Ground level contamination around Moscow during 1955 to 1959 increased about 5 fold. Ground-level atmospheric contamination in 1959 and 1960 was clearly seasonal. The highest contamination was observed in the second half of 1959. The concentration of  $\text{Sr}^{90}$  in the soil was about  $15 \mu\text{C}/\text{km}^2$  in 1959. 61 references. (R.V.J.)

**32359** (A/AC.82/G/L.615) GLOBAL'NOE RASPROSTRANENIE V ATMOSFERE I VYPADENIE NA ZEMLYU RADIOAKTIVNYKH PRODUKTOV YADERNYKH VZRYVOV. (OBZOR SOVREMENNOGO SOSTOYANIYA PROBLEMY). (Global Atmospheric Distribution and Fall-out of the Radioactive Products of Nuclear Explosions. (A Review of up-to-date Conditions). L. I. Karol and S. G. Malakhov (Akademiya Nauk S.S.S.R.). 1960. 102p.

An analysis is made of recent data on the atmospheric distribution of radioactive products from nuclear explosions. General atmospheric circulation, the Libby and Martell hypothesis on the mechanism of global fall-out, the Stewart, Machta, and Spar hypothesis on fall-out from the stratosphere, and the general hypothesis on the mechanism of global fall-out from the atmosphere are analyzed. 30 diagrams and 124 references are included. (R.V.J.)

**32360** (A/AC.82/G/L.616) SOSTAV I KONTSENTRATSIYA RADIOAKTIVNYKH ZAGRYAZNENII VOZDUKHA V INDIISKOM I TIKHOM OKEANAKH V 1959-1960. G. G. PO MATERIALAM EKSPEDITSII NA E/S "VITYAZ." (Composition and Concentration of Radioactive Contaminants in the Air in the Indian and the Pacific Oceans in 1959-1960, Based on Material Gathered by the Expedition on Board the Research Vessel "Vityaz"). V. N. Lavrenchik, G. N. Sofiev, and V. M. Shubko (Akademiya Nauk S.S.S.R.). 1960. 26p.

Data are presented on the distribution of nuclear explosion products in air over the western Pacific Ocean and northern and central Indian Ocean during October 1959 to April 1960. The results show that 2 years after tests, for the region  $43^\circ$  northern latitude to  $30^\circ$  south latitude, the fall-out concentration in the northern hemisphere is twice that in the southern, indicating a certain stratospheric reservoir activity. Data are plotted. It is shown that the minimum concentration in the stratosphere corresponds to a minimum in the troposphere. A variation in the ratio of maximum soil contamination to maximum tropospheric contamination is explained by meridional circulation and more favorable conditions of soil uptake. (R.V.J.)

**32361** (NP-9370) ESTUDIO DE LA ADSORCION DE PRODUCTOS DE FISION POR TIERRA DE EZEIZA. INFORME NO. 35. (Study of the Adsorption of Fission Products by the Soil of Ezeiza. Report No. 35). Leopoldo Jose Anghileri (Argentina. Comision Nacional de Energia Atomica, Buenos Aires). 1960. 13p.

A study was made of the adsorptive properties of Ezeiza soil for fission products using an adsorption column technique and adsorption on suspensions. The tests showed that the upper soil level in the zone of Ezeiza is a good

adsorber. For fission products in the presence of U, adsorption was over 75% of the activity, the fixation being dependent on the soil concentration, pH of the solution to be decontaminated, and the contact time. For  $\text{Sr}^{90}$  the values were close to 99% with concentrations of the order of 25 g of soil/100 cc of solution. For  $\text{Cs}^{137}$  the adsorption is almost complete (99%) with 15 g/cc. (J.S.R.)

**32362** A SAFETY DEVICE FOR RADIOACTIVE MEASUREMENTS IN WELL-LOGGING. D. M. Srebrodolski and A. A. Korzhev. Bezopasnost Truda v Prom., No. 3, 18-19 (1960).

Polonium-beryllium and cobalt sources of considerable activity requiring special precautionary measures are used in the radiometric investigation of bore-holes. A shielded tube for the boring apparatus and a removable container for the radioactive source are suggested. For investigating bore-holes with probes of different lengths, a number of extension pieces are selected, the hollow part of which can, if necessary, be filled with lead. This method completely eliminates the risk of radiation affecting the workers. (Public Health Eng. Abstr., 41: No. 9, 1961.)

**32363** A UNIFYING THEORY OF HIGH-ALTITUDE GEOPHYSICAL PHENOMENA AND GEOMAGNETIC STORMS. W. I. Axford and C. O. Hines (Defence Research Board, Theoretical Studies Group, Ottawa). Can. J. Phys., 39: 1433-64 (Oct. 1961).

Occurrence at high latitudes of a large number of geophysical phenomena, including geomagnetic agitation and bay disturbances, aurorae, and various irregular distributions of ionospheric electrons is discussed. These may all be related in a simple way to a single causal agency, namely, a certain convection system in the outer portion of the earth's magnetosphere. The source of this convection is taken to be a viscous-like interaction between the magnetosphere and an assumed solar wind, though other sources of an equivalent nature may also be available. The model is capable of accounting for many aspects of the phenomena concerned, including the morphology of auroral forms and the occurrence of "spiral" patterns in the loci of maximum intensities of several features. It also bears directly on the steady state of the magnetosphere, and in particular on the production of trapped particles in the outer Van Allen belt. In short, it provides a new basis on which a full understanding of these several phenomena may in time be built. (auth)

**32364** EFFECT OF RESONANCE CAPTURE ON THE DISTRIBUTION OF NEUTRONS IN ROCKS WITH LOW HYDROGEN CONTENT. I. A. Kozachok (Inst. of Geology, Academy of Sciences, Ukrainian SSR). Dopovidi Akad. Nauk Ukr. R.S.R., No. 4, 478-82 (1961). (In Ukrainian)

The effects of resonance capture and slowing down on neutron distribution in rocks were analyzed in relation to neutron exploration of boreholes. The age equation is solved as a first approximation for a point monoenergetic neutron source in unlimited hydrogen-free stratum. Neutron distribution in hydrogen bearing rocks differs from that in hydrogen-free rock, offering a practical method for utilizing neutron exploration. (auth)

**32365** EFFECT OF THE DISTRIBUTION OF BORON IN ROCKS ON THE ABSORPTION OF SLOW NEUTRONS. O. D. Belomar (Inst. of Mineral Resources, Academy of Sciences, Ukrainian SSR). Dopovidi Akad. Nauk Ukr. R.S.R., No. 4, 523-5 (1961). (In Ukrainian)

Equal concentrations by weight of boron were distributed in two sand strata. The boron mineral in one stratum was distributed uniformly, and in the other it was concentrated in glass flasks. Neutron well logging was carried out. The sensitivity of neutron well logging was found to depend on the mode of boron distribution. (auth)

**32366** INVESTIGATION OF THE METAMICT DECAY OF ZIRCONS WITH THE AID OF INFRARED ABSORPTION SPECTRUM. M. V. Akhmanova and L. L. Leonova (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, Moscow). *Geokhimiya*, No. 5, 401-14 (1961). (In Russian)

The metamict state of zircons was investigated with the aid of infrared absorption spectra. It was found that the metamict decay of zircons becomes apparent in the deformations of the  $\text{SiO}_4$ -tetrahedrons. The alteration in the zircon lattice, i.e., the accumulation of deformed  $\text{SiO}_4$ -tetrahedrons, occurs proportional to the increase of uranium content in the samples in the concentration interval  $1 \times 10^{-3}\%$  to 1%. The state of the crystalline zircon lattice with an uranium content of about 1% is completely metamict. It was ascertained that during the metamict transformation of zircon a dissociation into oxides does not occur. It is shown that zirconolites are in a metamict way altered zircons, that the water in them is of a molecular, absorbed nature. The investigation of infrared spectra is a very sensitive method for ascertaining the depth of metamict zircon transformation and therefore may be successfully used in the selection of samples suitable for the determination of absolute rock age. (auth)

**32367** BERYLLIUM DISTRIBUTION IN GRANITES. A. A. Beus (Inst. of Mineralogy, Geochemistry and Crystal Chemistry of Rare Elements, Academy of Sciences, Moscow). *Geokhimiya*, No. 5, 415-19(1961). (In Russian)

As a result of the statistical treatment of data from 375 quantitative determinations of beryllium content in granitoids of the USSR, the Korean People's Democratic Republic (KNR), Japan, and USA, the lognormal beryllium distribution in granites was confirmed and its average content was calculated to be 5 g/t (with an accuracy of 9.6%). Statistical parameters were calculated which characterize the peculiarities of beryllium distribution in two-mica and muscovitic biotites as well as in beryllium-containing albitized granites. On the basis of the available data it was shown that beryllium distribution in granites becomes complicated as the role of metasomatic processes in the granite formation increases, the complication in the beryllium distribution being displayed by the deviation from the lognormal distribution law. (auth)

**32368** ON THE ANOMALOUS COMPOSITION OF STRONTIUM IN MINERALS FROM METAMORPHIZED ROCKS. M. L. Yashchenko, E. S. Varshavskii, and I. M. Gorokhov (Laboratory of the Geology of Precambrian, Academy of Sciences, Moscow). *Geokhimiya*, No. 5, 420-5(1961). (In Russian)

The existence of minerals enriched in radiogenic strontium as a result of metamorphism was established with samples. The age for these minerals, obtained by the rubidium-strontium method proved to be anomalously high. A scheme for calculating the age of metamorphism is presented. (auth)

**32369** DETERMINATION OF THORIUM IN A SERIES OF ULTRABASIC ROCKS OF THE KOLA PENINSULA. A. I. Polyakov and M. P. Volynets (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, Moscow). *Geokhimiya*, No. 5, 426-32(1961). (In Russian)

A number of determinations of Th in rocks and minerals of three co-magmatic ultrabasic-alkaline massifs of the Kola peninsula was made with the aid of ion exchange-photometric methods. The total thorium content in these rocks is heightened compared to the common ultrabasic rocks. Thorium tends to accumulate intensively in the process of magmatic differentiation together with a number of lithophylic elements; thus it may serve as a geochemical indicator. (auth)

**32370** ON THE GEOCHEMISTRY OF BERYLLIUM. I. G. Ganeev (Moscow State Univ.). *Geokhimiya*, No. 5, 446-52(1961). (In Russian)

Peculiarities of beryllium behavior in one of the rare-metal deposits of Kazakhstan were studied. A vertical zonality in the distribution of beryllium in the vein was ascertained. The upper parts of the veins are associated with thick greysens with a great amount of mineralization. A complete lack of topaz and a strong decrease of cassiterite and fluorite along with beryllium mineralization is noted. An attempt was made to evaluate the influence of aluminium, fluorine, and calcium upon the order of mineral crystallization in the greysens and in the vein filling. (auth)

**32371** AGE MEASUREMENTS ON ANTARCTIC ROCKS (QUEEN MAUD LAND). Sarah Deutsch, E. E. Picciotto, and M. Reinharz (Université Libre, Brussels). *Nature*, 191: 1286-7(Sept. 23, 1961).

The results of absolute age measurements carried out on rocks from the Sör-Rondane Mountains are presented. The rubidium-strontium ages were measured on biotites obtained from various types of rocks: intrusive granite and diorite, gneiss and migmatites, granitic and pegmatitic veins. The isotopic ratios were measured with a 33 cm radius of curvature mass spectrometer equipped with an electron multiplier. The results indicate that the biotites are all the same age, approximately 475 million years, which corresponds in the stratigraphic scale to a Lower or Middle Ordovician age. (P.C.H.)

**32372** MONITORING OF RADIOACTIVITY IN FRESH WATER. A. H. Cooke. *Proc. Soc. Water Treatment Exam.*, 9: 172-99(1960)

In June 1948, the Atomic Energy Research Establishment at Harwell, Berkshire, began discharging liquid into the River Thames at Sutton Courtenay. Most of the original activity in the liquid is removed by coagulation, leaving a strictly controlled and limited amount in the resulting effluents. The original test procedures and the equipment is described. (*Public Health Eng. Abstr.*, 41: No. 9, 1961.)

**32373** ON SOME PROPERTIES OF THE IONIUM METHOD OF AGE DETERMINATION. I. E. Starik, Yu. V. Kuznetsov, V. K. Legin, and Z. N. Simonyak. *Radiokhimiya*, 3: 490-7(1961). (In Russian)

A radiochemical analysis was made of marine sedimentation containing radium, uranium, ionium, and thorium. The absence of radioactive equilibrium was established in the lower parts of columns where equilibrium is ordinarily accepted on the basis of ionium vertical distribution. The saturation of radium (in relation to ionium) found in upper levels of deep-water red clays indicate the feasibility of direct radium precipitation. Some data were obtained on sedimentation in the central region of the Indian Ocean that are in good agreement with published data. (R.V.J.)

**32374** DISTRIBUTION OF URANIUM IN ROCKS AND MINERALS OF MESOZOIC BATHOLITHS IN WESTERN UNITED STATES. Esper S. Larsen, Jr., and David Gottfried (Geological Survey, Washington, D. C.). *Geo-*



logical Survey Bulletin 1070-C. 1961. 46p. (ACCESS-102). (GPO)

Fluorimetric analyses for uranium were made on a variety of igneous rocks and minerals from the southern California, Sierra Nevada, Idaho, and Coast Range batholiths. The uranium content of nearly 200 igneous rocks, ranging from gabbro to quartz monzonite, indicated that during magmatic differentiation uranium increases from about a half a part per million in the gabbroic rocks to about four parts per million in quartz monzonites. The extreme differentiates, chiefly muscovite-quartz monzonites, showed a consistent decrease in their uranium content as compared with ordinary quartz monzonites of about the same chemical composition. The uranium analyses did not fall on smooth variation curves as did the major constituents but show considerable scatter. This was especially true for the rocks ranging in composition from granodiorite to the quartz monzonites. Taking into consideration the areas underlain by the various rock types, the weighted-average uranium contents of the batholiths are as follows: southern California, 1.7 ppm; Sierra Nevada, 2.7 ppm; Idaho, 2.5 ppm; and the Coast Range, 2.7 ppm. The weighted-average uranium content of the four batholiths is approximately 2.5 ppm. Uranium determinations on the major minerals and many of the accessory minerals of 26 igneous rocks showed that in most rocks the major rock-forming minerals contain the bulk of the uranium present in the rock. In general, there was an

average increase in the uranium content of a given mineral from the mafic to the siliceous rocks. The amount of uranium soluble in acid (hot 1 + 4 HCl) was determined in six igneous rocks representing the major rock type of the southern California batholith. The percent soluble uranium ranged from 40% in a calcic gabbro to 83% in a quartz monzonite. Similar acid treatment of the major minerals of four igneous rocks showed that the bulk of the uranium contained in separated fractions of quartz, feldspar, and the mafic minerals is readily dissolved. (auth)

**32375** RELATION OF URANIUM DEPOSITS TO TECTONIC PATTERN OF THE CENTRAL CORDILLERAN FORELAND. Frank W. Osterwald and Basil G. Dean (Geological Survey, Washington, D. C.). Geological Survey Bulletin 1087-I. 1961. 57p. (ACCESS-103). (GPO).

The Cordilleran foreland, one of the major tectonic units of western North America, is described. A tectonic map was compiled to study the geologic setting of uranium deposits within the region and to determine what relationships may exist between the distribution of uranium deposits and the regional tectonic pattern. The map shows faults, folds, uranium deposits, and outcrop areas of rocks of selected types and ages. Fifteen units of the Cordilleran foreland, each characterized by one or more prominent large-scale structures, are discussed. The relations of uranium deposits to large-scale structures and to structural patterns are described. (M.C.G.)

# HEALTH AND SAFETY

Refer also to abstract 32319

**32376** (APAE-84(Add.III)) HAZARDS REPORT FOR SM-1 CORE II WITHOUT THE SM-1 CORE I HIGH BURNUP ELEMENTS AND WITH THE PM-1-M-2 ELEMENT. (Cover carries title: HAZARDS REPORT FOR INSERTION OF THE PM-1-M-2 ELEMENT IN THE SM-1 CORE II.) J. R. Coombe, D. H. Lee, and F. T. Mathews (Alco Products, Inc., Schenectady, N. Y.). Oct 7, 1961. Contract AT(30-1)-2639. 10p.

The removal of both SM-1 Core I high burnup elements from SM-1 Core II and the insertion of the PM-1-M-2 element and one SM-1 Core I spare element in SM-1 Core II is discussed. Nuclear and thermal characteristics of Core II with these changes are presented and conclusions related to the changes in the hazard potential are made. (auth)

**32377** (APAE-84(Add.IV)) HAZARDS REPORT FOR SM-1 CORE II WITH THE SM-1 CORE I HIGH BURNUP ELEMENTS REPLACED WITH SM-1 CORE I SPARE ELEMENTS. J. R. Coombe, D. H. Lee, and F. T. Mathews (Alco Products, Inc., Schenectady, N. Y.). Oct. 9, 1961. Contract AT(30-1)-2639. 10p.

The removal of both SM-1 Core I high burnup elements from the SM-1 Core II and the insertion of two SM-1 Core I spare elements in their places are discussed. Nuclear and thermal characteristics of Core II with this change are presented and conclusions related to the change in hazard potential are made. (auth)

**32378** (APEX-715) AIRCRAFT NUCLEAR PROPULSION DEPARTMENT NUCLEAR SAFETY GUIDE. William A. Pryor (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). June 1961. Contracts AF33 (600)-38062 and AT(11-1)-171. 29p.

The limitations and operating techniques which were in effect at ANPD for the prevention of criticality accidents are summarized. The standards followed by the atomic industry were followed; however, the safe mass of  $U^{235}$ , moderated with beryllium oxide and hydrogenous materials was based upon criticality experiments conducted at ANPD. Although the guide was primarily for the use of the ANPD nuclear safety control organization, it may also be of assistance to designers and operating management in maintaining nuclear safety. (auth)

**32379** (DASA-539B) SECOND SPECIAL REPORT ON THE HIGH ALTITUDE SAMPLING PROGRAM (HASP). Technical Analysis Report. Albert K. Stebbins, III. (Defense Atomic Support Agency, Washington, D. C.). Aug. 1, 1961. 243p.

Progress is reported in the High Altitude Sampling Program (HASP). A recalibration of the U-2 ducts diminished the previous discrepancy noted in the flow rates. Absolute values of radionuclide concentrations were increased 8 to 13% by this recalibration. A discussion on the structure and nature of the 0.1 to 1.0 micron family of naturally occurring stratospheric aerosol is presented. This dust layer of ammonium sulfate appeared to be generated in the stratosphere and may play an important role in lower stratospheric fallout processes. A detailed discussion of stratospheric concentrations of a number of nuclides is presented.  $Sr^{90}$  and  $W^{185}$  inventories and distributions from August 1957 to May 1960 are discussed.

By May 1960 maximum tungsten values were found in the lower altitude equatorial regions while maximum strontium values were found in the higher altitude polar regions. The tungsten stemmed from low altitude HARDTACK shots only, while the strontium appeared to show influx from Teak and Orange. The tungsten and strontium concentration variations shed considerable light on stratospheric mixing processes.  $Ba^{140}$ ,  $Sr^{88}$ , and  $Ce^{144}$  concentrations assisted in determining the age of debris and thus allow following of stratospheric mixing and transfer processes. A number of definite seasonal effects were noted. Transfer from the tropics to the polar regions was greatest during the winter and all but ceased during the fall. Various possible modes of tropospheric-stratospheric interchange are discussed. A detailed discussion of fallout from Teak and Orange debris is presented.  $Rh^{102}$  data suggested at least 10% of Orange was in the lower stratosphere by May 1960.  $Ce^{144}$  and  $Sr^{90}$  data suggested that 25% of the debris in the polar regions in early 1960 was from Teak and Orange. A half residence time of about 5 years in the mesosphere for Teak and Orange was suggested. Entry into the lower stratosphere apparently proceeded through rapid downward mixing in the polar regions during the winter night. A study of natural radionuclides in the stratosphere is presented. This assisted in measurement of stratospheric processes. Elements studied include  $C^{14}$ ,  $H^3$ ,  $Pb^{210}$ ,  $Be^7$ , and  $P^{32}$ .  $Be^7$  and  $P^{32}$  concentrations in the stratosphere were about that expected from cosmic ray production.  $Pb^{210}$  in the stratosphere may partially result from equatorial bomb tests. Comments are presented on surface fallout measurements which corroborate the HASP measurements. Seasonal and latitudinal effects were noted. The contributions of French tests were calculated. The hazard of radioactive fallout was assessed by nuclide and dose type. The 30 year genetic or whole body dose in the U. S. from  $Cs^{137}$  and elements of shorter half life is shown to be less than 100 millirem or less than 3% of the natural background. The lifetime, 70 year, somatic bone dose to children in the U. S. is shown to be about 200 millirem of which half is from  $Sr^{90}$ . This is less than 2% of the population MPD. U-2 operational scenes, constants and conversion factors, and a summary of nuclear detonations are included. (auth)

**32380** (HW-68929) NUCLEAR SAFETY IN CHEMICAL AND METALLURGICAL PROCESSING OF PLUTONIUM. E. D. Clayton (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 1961. Contract AT(45-1)-1350. 50p.

A review was made of those types of criticality problems encountered in a typical plutonium processing and metal fabrication plant. A brief discussion is given of some of those criticality data which are of general interest in nuclear safety application, and of some of those data of limited application, but which are of special interest to specific processes. Curves are presented, based on multigroup diffusion theory, which show the estimated critical mass and infinite cylinder diameters for homogeneous  $PuO_2$ -water mixtures and the critical mass for Pu-Al alloy. Applied methods of criticality control in plutonium processing and fuel element fabrication are reviewed. A list of typical administrative procedures, which have been used in effecting criticality control, is given. The proposed general program



of studies for the new Hanford Plutonium Critical Mass Laboratory, which is being undertaken to obtain needed criticality data for Pu solutions and precipitates of plutonium, is discussed. (auth)

**32381** (HW-69083) ON THE ORIGIN OF RADIOPHOSPHORUS IN HANFORD REACTOR EFFLUENT WATER. W. B. Silker (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 20, 1960. Contract AT(45-1)-1350. 21p.

Additions of sulfate and phosphate ions were made to reactor cooling water and the effluent concentration of  $P^{32}$  and several other radioisotopes was monitored. From these data it was estimated that  $\frac{2}{3}$  of the  $P^{32}$  was produced by the thermal neutron reaction with phosphorus and the remaining  $\frac{1}{3}$  was from the fast neutron reaction with sulfur. A mathematical analysis of the  $P^{32}$  release curve, after addition of phosphorus was stopped, resulted in a three-component system with retention half times of 7 hr, 30 hr, and 27 days. It was calculated that only 0.3% of the influent phosphorus atoms engaged in a reaction with the corrosion film in the reactor. (auth)

**32382** (NP-10681) ASSAY OF STRONTIUM-90 IN HUMAN BONE IN THE UNITED KINGDOM, RESULTS FOR 1960, PART I, WITH SOME FURTHER RESULTS FOR 1958 AND 1959. Medical Research Council Monitoring Report Series No. 2. (Gt. Brit. Medical Research Council, London). May 29, 1961. 15p.

Data are tabulated on the levels of  $Sr^{90}$  in samples of human bone collected in Great Britain between 1958 and 1960. Data on natural Sr levels in bone samples are included. (C.H.)

**32383** (NP-10861) DEFENSE—NUCLEAR WEAPON ACCIDENT PROGRAM; STRATEGIC AIR COMMAND MANUAL. (Strategic Air Command, Offutt AFB, Neb.). Oct. 18, 1961. 107p. (SACM-355-1)

This manual supersedes Annex IV, 23 May 1960, to SACR-355-1 and Change 1, 12 September 1960, and Change 2, 9 March 1961, to Annex IV, SACR-355-1.

A manual for use in the SAC nuclear weapon accident (Broken Arrow) program is presented. Instructions and procedures to be used in organizing and training base level activities in the over-all base response to a nuclear accident are given. Detailed response procedures used by base disaster control teams in coping with a nuclear accident are outlined. (M.C.G.)

**32384** (TID-13832) SUMMARY OF THE ENVIRONMENTAL RADIATION LEVELS AND CONCENTRATIONS. (Goodyear Atomic Corp., Portsmouth, Ohio). Jan. 1961. Contract AT(33-2)-1. 9p.

The results of air and water monitoring show that the average value for any single location has not exceeded the maximum permissible concentrations or exposure levels for the population. The high, low, and average values of each location are tabulated. (P.C.H.)

**32385** (TID-13833) SUMMARY OF THE ENVIRONMENTAL RADIATION LEVELS AND CONCENTRATIONS, APRIL 1961. (Goodyear Atomic Corp., Portsmouth, Ohio). Contract AT(33-2)-1. 11p.

**32386** (TID-13836) SIC PROTOTYPE REACTOR FACILITY. Quarterly Environmental Monitoring Report, July-September 1960, Volume I, Number 3. (Combustion Engineering, Inc. Naval Reactors Div., Windsor, Conn.). Oct. 1960. Contract AT(30-3)-519. 9p.

Measurements of radioactivity in the Farmington River, in waste effluent, and air showed no significant contribu-

tion of radioactivity to the environment. Radioactivity discharged to the environment, under controlled conditions, during waste disposal operations, was in full compliance with the recommendations of the NCRP and the radiation protection standards established by the Federal Radiation Council. (P.C.H.)

**32387** (TID-13846) QUARTERLY SUMMARIES, BACKGROUND AND FALLOUT MONITORING PROGRAM. Second and Third Quarter, 1960. Louis B. Silverman and Evan M. Romney (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). Contract AT(04-1)-GEN-12. 5p.

Over-all monthly averages are tabulated for the daily air, gum paper, rainfall samples, and gamma background in West Los Angeles. Decreases or continued low levels were found in every type sample. (P.C.H.)

**32388** (TID-13869) BACKGROUND AND FALLOUT MONITORING PROGRAM. Quarterly Summary for the Fourth Quarter 1960. Louis B. Silverman (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). Feb. 15, 1961. Contract AT(04-1)-Gen-12. 4p.

**32389** CESIUM 137 BURDENS IN SWEDISH LAPLANDERS AND REINDEER. Kurt Liden (Univ. of Lund, Sweden). Acta Radiol., 56: 237-40 (Sept. 1961). (In English)

Measurements in the whole-body counter at Lund have shown the  $Cs^{137}$  burden in Swedish Laplanders to be 20 to 40 times as high as in a control group of Lund. A diet of reindeer meat containing about 25 nc  $Cs^{137}$  per kg is the main source of this unique  $Cs^{137}$  level in human subjects. (auth)

**32390** SAFETY ASSESSMENTS IN THE NUCLEAR INDUSTRY. PART 2. A. Quinton (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.). Chem. & Process Eng., 42: 447-50 (Oct. 1961).

Safety criteria for the nuclear industry are reviewed. Topics discussed include radiation shielding, contamination problems, and the duty of the Health Physics Services. It is pointed out that in the construction of any nuclear chemical plant, an over-all statement of its design is essential for safety assessments and for the correct provision of safety facilities. (C.H.)

**32391** EFFECT OF ROASTING ON RADIOSTRONTIUM IN FRESH HAM. CONCENTRATION IN BONE AND MEAT. J. C. Bartley and E. F. Reber. J. Am. Dietet. Assoc., 37: 466-7 (1960).

Four pigs aged 7 weeks were given, by mouth,  $SrCl_2$  containing  $Sr^{90}$  and  $Sr^{89}$ . Seven days later they were killed and single hams prepared from the carcasses were roasted. The femurs of the roasted hams contained about the same amount of radioactive strontium as the femurs of paired, uncooked hams. The concentration of labeled Sr in terms of percentage of dose per kg was higher in roasted meat and bone than in the raw tissues. (Public Health Eng. Abstr., 41: No. 9, 1961.)

**32392** RADIOACTIVE FALLOUT AND DRINKING WATER. Ernest A. Snow. J. New Engl. Water Works Assoc., 75: 27-37 (Mar. 1961).

The salient factors regarding the hazards of radiation in drinking water supplies are presented from the viewpoint of the waterworks operator. While emphasizing the hazards from fallout, other sources of radioactive wastes which might be introduced into domestic water supplies are also discussed. Data are given on the effects of radioactivity by natural agents with primary consideration

to the water environment and a resume of current methods of decontamination. (Public Health Eng. Abstr., 41: No. 9, 1961.)

**32393 DESCRIPTION OF THE ACCIDENT AND SUBSEQUENT EVENTS.** Thomas L. Shipman (Los Alamos Scientific Lab., N. Mex.). J. Occupational Med., 3: No. 3, Special Suppl., 147-9 (Mar. 1961)

An accidental critical excursion took place in the Pu recovery plant of the Los Alamos Scientific Laboratory on Dec. 30, 1958. One employee received a fatal radiation dose calculated as 12,000 rads to the upper abdomen and two other employees received radiation doses calculated as 130 rads and 35 rads. These figures include dosage from neutrons and gamma radiation. The accident occurred in an area where solutions usually containing less than 0.1 gm Pu/l were processed for recovery of Pu. Events that preceded the excursion are reviewed and the accident and subsequent events are described. (C.H.)

**32394 HEALTH PHYSICS STUDIES AND AREA RADIATION LEVELS.** James N. P. Lawrence (Los Alamos Scientific Lab., N. Mex.). J. Occupational Med., 3: No. 3, Special Suppl., 184-7 (Mar. 1961).

Health physics studies are described which were used to estimate area radiation levels from an accidental critical excursion in a Pu processing plant. It is pointed out that the principal health hazard in this area was considered to be  $\alpha$  radiation from Pu and monitoring personnel assigned to the building were primarily concerned with incidents or accidents involving  $\alpha$  contamination. Procedures used in estimations of levels of radiation exposure to personnel are summarized. (C.H.)

**32395 REPORT ON OTHER PERSONNEL EXPOSED.** Thomas L. Shipman (Los Alamos Scientific Lab., N. Mex.). J. Occupational Med., 3: No. 3, Special Suppl., 188-90 (Mar. 1961).

A number of individuals received measurable overexposures to radiation from a critical excursion in a Pu processing plant. Details of pathological findings are presented for two individuals exposed to doses of 130 rads and 35 rads of primarily  $\gamma$  exposure. The only significant findings in both cases consisted of alterations in the blood counts. Findings are compared with changes observed in the Rongelap natives and Oak Ridge workers exposed to high level radiation doses. (C.H.)

**32396 EXAMINATION OF THE RADIOACTIVITY OF SOME HUNGARIAN FOODS.** Ilona Gal and Johanna Toperczer. Magyar Kem. Folyoirat, 66: 436-9 (1960).

Hungarian foods, (vegetables, fruits, milk, and fish) gathered in 1959, were examined. In 37 samples total activity varied from 0.71 to 19.6, activity of the  $K^{40}$  fraction 0.0-19.6, and of the  $Sr^{90}$  fraction 0.13-4.05  $\mu\mu\text{Ci}$ . (Public Health Eng. Abstr., 41: No. 9, 1961.)

**32397 MIDGE LARVAE AS INDICATORS OF RADIOACTIVE POLLUTION.** La Verne L. Curry (Central Michigan Coll., Mount Pleasant, Mich.). Purdue Univ., Eng. Bull., Ext. Ser., No. 106, 269-80 (Mar. 1961).

The role of midge larvae, or blood worms, as an indicator or radioactive pollution of surface waters was investigated. The larvae of two species were obtained from a silt deposit and studies were made on larvae ecology and feeding habits and their position in specific food chains. The uptake of  $Fe^{59}$  and  $P^{32}$  by the larvae was measured. The results of these studies indicate that much has to be learned of the ion exchange between water-hydrosol systems and hydrosol-larvae systems. Both experiments using  $P^{32}$  and  $Fe^{59}$  indicate that the exchange of the radionuclides at the mud-water interphase occurs within 6 hr and that there is considerable penetration by the radionuclides. It was con-

cluded that the larvae of *T. plumosus* and *T. decorus* cannot be used as indicators of water pollution due to  $P^{32}$  and  $Fe^{59}$  because of the low rate of uptake by the larvae as compared to the resulting activity of the hydrosol from the water. (C.H.)

**32398 A NOTE ON MYLAR FILM DOSIMETRY.** Victor H. Ritz (U. S. Naval Research Lab., Washington, D. C.). Radiation Research, 15: 460-6 (Oct. 1961).

The ultraviolet transmission of Mylar films, 0.00025 inch and 0.007 inch thick, can be used as a dosimeter to cover the absorbed dose range from  $5 \times 10^6$  rads to  $10^9$  rads. The 0.007-inch film exhibits a rapid initial fading in optical density, arriving at a constant value in less than 24 hours, whereas the 0.00025-inch Mylar is free from fading. Both thicknesses of film exhibit a dose rate dependence. A correction can be made for this if the exposure time is known and the dose rate does not vary too much during the exposure. The low atomic number of Mylar film makes it insensitive to variations in the spectral distribution of the  $\gamma$ -ray field, and its small mass minimizes the perturbation of the field caused by its presence. The system is simple, reproducible ( $\pm 5\%$ ), and economical. (auth)

**32399 ON THE RADIOACTIVE CONTAMINATION AND ITS REMOVAL. REPORT 8. AIR CONTAMINATION BY RADIOACTIVE CONTAMINATED CLOTHS.** Kikuzi Kimura. Rôdô Kagaku, 37: 289-94 (June 1961).

An experimental study on radioactive air contamination by radioactive contaminated cloths was carried out by the following method: the radioactive contamination of test pieces of new and stained cloths (wool, cotton, linen, silk, rayon, nylon, tetron, vinylchloride, polyethylene, rubber, and leather) was caused by dropping 0.2cc of  $H_3P^{32}O_4$ ,  $H_2S^{36}O_4$ ,  $Ca^{45}Cl_2$ , or  $NaI^{131}$  solution (corresponding 1  $\mu\text{Ci}$ ) and drying them. These radioactive contaminated test pieces were scrubbed in an experimental box with a brush or cloth materials the same as the test pieces. The radioactive contamination of air in the experimental box was measured with the membrane filter and the gas flow counter. Results obtained were as follows: The radioactive contamination of air caused by such a procedure was 2-120 dpm per 10 liters of air. The radioactive contamination of air was more striking in the case of stained cloths than in the case of new unstained cloths. The relation between the contamination of air and cloths can be expressed as: air contamination (dpm/ $m^3$ ) =  $(0.038 \pm 0.007) \times$  surface contamination of cloths (dpm/ $cm^2$ ). (Public Health Eng. Abstr., 41: No. 9, 1961.)

**32400 RADIOISOTOPES IN MEDICINE. A GENERAL GUIDE FOR PHYSICIANS AND HOSPITAL PERSONNEL.** North Chicago, Illinois and Oak Ridge, Tennessee, Abbott Laboratories-Radio-Pharmaceuticals, 1961. 20p.

The status of radioisotopes in medicine is reviewed briefly. Topics discussed include the genetic effects of radiation, maximum permissible doses of radiation, radiation shielding and other means of reducing radiation exposure, the care of patients receiving radiopharmaceuticals, and precautions for protecting hospital personnel and others who may come in contact with patients containing radioactive material. (C.H.)

**32401 METHOD OF PURIFYING RADIOACTIVE WATER.** Degremont Aci, M. Schmitt, and M. Neveu. French Patent 1,217,216. Dec. 7, 1959.

The utilization of lithothamnium calcareum as an ion exchanger for the decontamination of radioactive water is described. In order to retain cobalt and strontium the ion exchanger is mixed with calcium silicate or borate; alternatively sodium phosphate is added to the water prior to the purification process. (NPO)



# INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

**32402** (AGN-3027-15) THE RADIOACTIVE, INDEPENDENT TRANSDUCER-RECEIVER (RIT-R) SYSTEM. Final Report, March 16, 1959–August 12, 1960. (Aerojet-General Nucleonics, San Ramon, Calif.). Nov. 1960. Contract AT(04-3)-251. 166p.

The techniques and experiments used to develop a prototype wireless transducer system are described. The system is called the Radioactive, Independent Transducer-Receiver and is based on nuclear reactions. Fabrication techniques and experimental results for electrodeposition of the  $\text{Cm}^{242}$  sources used in the radioactive transducer are included. Preliminary measurements made with the prototype are also described. (auth)

**32403** (NYO-9987) THE ACCELERATING EFFECT OF ADDITIVES ON RADIATION-INDUCED GRAFT POLYMERIZATION. Quarterly Summary Report April 1, 1961–June 30, 1961. George Odian and Terese Acker (Radiation Applications Inc., Long Island City, N. Y.). July 18, 1961. Contract AT(30-1)-2318. 23p.

The graft polymerization of styrene to nylon films in the presence of methanol was investigated under mutual irradiation conditions. Using one film thickness, the rate of graft polymerization was studied as a function of dose rate. The rate of polymerization was found to vary as the 0.5 power of the dose rate. Therefore chain termination in this grafting system is bimolecular. At a constant dose rate the rate of graft polymerization was not a function of film thickness. Linear plots of percent graft vs time were obtained for the initial stages of reaction and the slopes differed only slightly for the three film thickness. Therefore, in the beginning stages, the grafting reaction was non-diffusion controlled and occurred volumetrically throughout the base polymer. A study was made to determine whether grafting takes place under steady state conditions by determining the rate of post-irradiation graft polymerization after two different periods of mutual irradiation. Phase equilibria studies were carried out for various polymer-monomer-solvent systems whose grafting behavior was previously investigated so as to calculate certain kinetic parameters. (auth)

**32404** (SRO-55) AN INVESTIGATION OF THE USE OF RADIOACTIVE ISOTOPES FOR DETERMINING THE SURFACE AREA OF POWDERED MATERIALS BY SORPTION METHODS. Final Report covering Period April 1, 1959 to March 31, 1961. Margaret C. Kordecki and Miriam B. Gandy (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Contract AT(38-1)-202. 67p.

A technique is developed for determining surface areas of materials, by measuring the sorption of  $\text{C}^{14}$ -labeled stearic acid. The effects of drying methods, drying times, and sorbent-sorbate contact times are studied. Measurements are also made using  $\text{C}^{14}$ -labeled formic, acetic, hexanoic, and lauric acids and sodium acetate and sodium hexanate. Methanol, benzene, and water are used as solvents. (T.F.H.)

**32405** TENDERNESS OF POULTRY MEAT. I. EFFECT OF ANESTHESIA, COOKING, AND IRRADIATION. W. J. Stadelman and R. G. Wise (Purdue Univ., Lafayette, Ind.). Food Technol., 15: 292-4(1961).

Several factors influencing tenderness of poultry meat are discussed. Shear values of breast meat are reported as affected by cooking before freezing, gamma irradiation, and anesthetization before slaughter. Cooking before freezing and gamma irradiation of adequately aged poultry exert only minor effects, which appear to be nonadditive. The use of nembutal as an anesthetic (to reduce bruising in getting chickens onto the killing shackles) significantly extends the period of maximum toughness as determined by shear values of cooked breast muscle. (auth)

**32406** THE AECL IRIIDIUM-192 RADIOGRAPHY HANDBOOK. Technical Bulletin IR-1. (Atomic Energy of Canada Ltd. Commercial Products Div., Ottawa). July 1961. 44p. (AECL-1154)

A discussion is given of the principles and methods of the use of iridium-192 in radiography, in terms of: iridium-192 radiography sources; fundamentals of radiography; equipment; practical radiography; interpretation of radiographs; and radiation safety. A glossary is included of terms used in radiography. (B.O.G.)

# ISOTOPE SEPARATION

**32407** (ORNL-3176(p.17-25)) CHEMICAL SEPARATION OF ISOTOPES. D. A. Lee, A. A. Palko, et. al. (Oak Ridge National Lab., Tenn.).

Ion exchange studies were made in nonaqueous solvents to compare these systems with aqueous systems previously examined. Rates of swelling of resins in organic solvents, rates of exchange of alkali-metal ions between salts dissolved in the solvents and ions on cationic resins, and distribution coefficients were measured. The water contents of Decalco exchangers and Dowex 50-X16 in the  $\text{NH}_4^+$ ,  $\text{Li}^+$ , and  $\text{K}^+$  forms were also compared. Characterization of  $\text{BF}_3$ -organic complexes continued. Single-stage separation factors,  $\text{BF}_3$  solubility, and vapor pressures of selected complexes were studied. Labeled complexes of  $\text{B}^{10}$  and  $\text{B}^{11}$  were prepared for infrared and Raman spectral studies. The separation factor for oxygen isotopes in the gas/liquid system paraldehyde-acetaldehyde is  $1.017 \pm 0.002$  at  $26^\circ\text{C}$ . The single-stage separation factor for oxygen isotopes ( $\text{O}^{18}/\text{O}^{16}$ ) for the dimethyl ether-HCl system was found to be 1.004 at  $-32^\circ\text{C}$ , with  $\text{O}^{18}$  enriching in the liquid phase. The vapor pressure and the extent of dissociation of the complex were also studied. Nitrogen isotope separation with  $(\text{CH}_3)_4\text{N} \cdot \text{Hg}$  vs  $(\text{CH}_3)_4\text{N}^+$  and  $\text{NO}$  vs  $\text{K}_2\text{SO}_3(\text{NO})_2$  was not possible because of unstable systems. Gaseous  $\text{NO}$  did not exchange with the  $\text{NO}$  in  $(\text{C}_2\text{H}_5)_2\text{NH}_2^+(\text{C}_2\text{H}_5)_2\text{N}(\text{NO})_2^-$ . Exchange of calcium between calcium amalgam and aqueous calcium formate gave a separation factor of 1.0013 per mass unit. The solubility of calcium in mercury and the heat of reaction were determined. More than 70 g of 95 to 99%  $\text{N}^{15}$  were separated in the Nitrox cascade. Operation of this facility was suspended until a need for additional  $\text{N}^{15}$  develops. Construction of the  $\text{O}^{17}$  cascade was completed during fiscal year 1961. Preoperational testing of the water distillation cascade is nearing completion. Productive operation is expected to begin soon. A nuclear-magnetic-resonance structural study of alkyl carbamates is in progress. A number of configurations were eliminated and some tentative structures assigned. No single structure seems to apply to all the species studied. The observation of the infrared and Raman spectra of the boron trifluoride-dimethyl ether complex was continued with the use of  $\text{B}^{10}$  and  $\text{B}^{11}$ , and deuterated molecules were prepared. Isotopic partition-function ratios for various nitrogen-containing molecules and ions were calculated. A general computer program for computing the vibrational force constants for molecules containing up to 15 atoms was written. The mass spectrum of  $\text{N}_2\text{O}$  was studied, using various  $\text{N}^{15}$ -containing species. Boron trifluoride samples were analyzed mass-spectrometrically by peak-height measurements at masses 10 and 11 and also at 48 and 49. Samples of  $\text{CO}$ ,  $\text{CO}_2$ ,  $\text{N}_2$ , and  $\text{O}_2$  were assayed by dual collection. Two test samples of  $\text{CO}_2$  were compared over a period of several months and showed a ratio of 46/44 ratios of  $1.0155 \pm 0.0002$  at the 95% confidence level. (auth)

**32408** (TID-13673) THE MAXIMUM SEPARATIVE CAPACITY OF A GAS CENTRIFUGE. E. Von Halle (Oak Ridge Gaseous Diffusion Plant, Tenn.). Nov. 29, 1960. Contract [W-7405-Eng-26]. 16p. (KOA-748(Revised)).

A tabulation of values of the maximum separative capacity of a centrifuge as a function of the peripheral speed and operating temperature of the centrifuge is pre-

sented. The results are also shown graphically. A derivation of the equation for the maximum separative capacity is given. Values for the density and coefficient of self-diffusion product for  $\text{UF}_6$  were calculated from viscosity data. (M.C.G.)

**32409** (AEC-tr-4821) IMPROVEMENTS IN APPARATUS FOR THE SEPARATION OF ISOTOPES. Giovanni Perona. Translated for Oak Ridge Gaseous Diffusion Plant, Tenn. from Italian Patent No. 550,379, Oct. 26, 1956. 8p.

A description is given of an apparatus for obtaining the separation of mixtures of isotopes, or more generally, the separation of gaseous mixtures by gaseous diffusion principles which make use of the differential velocity with which molecules of different weights diffuse through capillary tubes or micropores, when the diameter of the pores is of the same order of magnitude of the average free molecular path. The theoretical separation factor ( $\alpha$ ) is given by:  $\alpha_1 = m_1/m_2$ , where  $m_2$ ,  $m_1$  are the masses of the heavier and lighter molecules, respectively. The apparatus is shown schematically. (B.O.G.)

**32410** (AEC-tr-4823) CENTRIFUGE UTILIZING THERMODIFFUSION. Masashi Hoyen. Translated for Oak Ridge Gaseous Diffusion Plant, Tenn., from Japanese Patent No. 8867/57, Oct. 18, 1957. 6p.

A centrifuge which can easily separate a large amount of isotope by the application of thermal diffusion in the centrifuge is described. The thermal diffusion field is maintained by keeping one side of the centrifuge at a higher temperature than the other side. Thus the outer circumference at lower temperature is compression-heated and the medium is passed through the inner circumference into a turbine where the medium is expansion-cooled to recover the energy of the medium. After this medium is passed through the outer circumference, it is circulated back to the compressor. (N.W.R.)

**32411** (AEC-tr-4824) MANUFACTURING PROCESS OF A POROUS SUBSTANCE FOR THE SEPARATION OF ISOTOPES. Translated for Oak Ridge Gaseous Diffusion Plant, Tenn. from French Patent No. 1, 198, 235, Dec. 4, 1959. 9p.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 14, abstract no. 21868.

**32412** (AEC-tr-4825) ON THE KINETICS OF BORON ISOTOPE EXCHANGE BETWEEN BORON TRIFLUORIDE AND ITS ANISOLE COMPLEX. G. M. Panchenkov, A. V. Makarov, and B. V. Rosynov. Translated for Oak Ridge Gaseous Diffusion Plant, Tenn. from *Vestnik Moskov. Univ.*, Ser. II., 15: No. 3, 7-10(1960). 8p.

An apparatus is described for studying heterogeneous isotope gas-liquid exchange under conditions of intensive mixing of both phases. It was confirmed that isotope equilibrium in the exchange of boron fluoride and its anisole complex is established very quickly, in the course of several minutes, when the phases are mixed. (auth)

**32413** SEPARATION OF ISOTOPES. H. London, ed. London, George Newnes Limited, 1961. 500p. 80s.

The various isotope separation methods are described and are brought into a common perspective in order that a selection may be easily made for each particular isotope separation problem. The separation theory of statistical processes is presented. The photochemical and elec-



tromagnetic methods, reversible statistical processes, and irreversible statistical processes are covered. (N.W.R.)

**32414 THE THERMODYNAMICS OF THE ADSORPTION OF HYDROGEN AND THE EXCHANGE REACTION WITH D<sub>2</sub> OVER METAL CATALYSTS.** G. C. A. Schuit, N. H. de Boer, G. J. H. Dorgelo, and L. L. van Reijen (Koninklijke/Shell-Laboratorium, Amsterdam). p.39-50 of "Chemisorption." New York, Academic Press Inc. and London, Butterworths Scientific Publications, 1957.

The heats of adsorption of H<sub>2</sub>, the rate of exchange between H<sub>2</sub> + D<sub>2</sub>, and the rate of exchange between adsorbed D and gaseous H<sub>2</sub> on some metal-on-SiO<sub>2</sub> catalysts (especially Ni-SiO<sub>2</sub>) were measured. The surface-gas exchange showed the metal surface to be heterogeneous. With the aid of the theory of the transition state the activation energies of surface-gas exchange could be calculated on the basis of either the Bonhoeffer-Farkas (I) or the Eley-Rideal (II) mechanism. The most frequent activation energy according to mechanism I agreed satisfactorily with the most frequent heat of desorption at full coverage, but the extrapolated value for the rate of the H<sub>2</sub> + D<sub>2</sub> exchange was too high by a factor 10<sup>3</sup>. On the other hand, an activation energy much lower than the heat of desorption could be calculated from mechanism II, and this was found to agree in rate with the H<sub>2</sub> + D<sub>2</sub> exchange. However, if this was accepted, it was not clear why mechanism I does not operate as it should. (auth)

**32415 PROTIUM-DEUTERIUM EXCHANGE BETWEEN ETHYLENE AND  $\gamma$ -ALUMINA.** H. Kloosterziel (Koninklijke/Shell-Laboratorium, Amsterdam). p.76-84 of "Chemisorption." New York, Academic Press Inc. and London, Butterworths Scientific Publications, 1957.

The isotope exchange between deuterium-containing aluminum oxide and ethylene was studied. Previous investigations showed that it is theoretically possible to obtain, from the distribution of deuterium over the ethylene molecules, detailed information on the mechanism and rates of the reactions occurring at the surface. The experimental distributions showed that an ethylene molecule is adsorbed at one carbon atom and that only the hydrogen atoms on the other carbon atom are exchangeable. The probabilities for desorption and exchange of one hydrogen atom are equal. The kinetics of the reaction showed that two molecules are involved in one act of desorption. The combination of these data led to a definite concept of the chemisorption and reactions of ethylene on aluminum oxide, of which the most striking feature is the adsorption of two molecules at one active site. (auth)

**32416 METHOD OF CENTRIFUGE OPERATION.** (to United Kingdom Atomic Energy Authority). British Patent 879,118. Oct. 4, 1961.

A method of operating a centrifugal separator is described which produces more efficient separation of fluid mixtures, particularly gaseous isotopic mixtures, and is applicable to centrifuge cascades. The method comprises passing a first stream of the fluid in an axial direction through the central portion of a centrifuge rotor, passing a second stream through the peripheral portion of the rotor countercurrent to the first stream, and rotating the rotor to effect separation. Besides the advantage of more efficient separation, the method enables smaller centrifuges to be used and centrifuge cascades to be subdivided into independently controllable units. (D.L.C.)

**32417 IMPROVEMENT IN METHODS OF ISOTOPE SEPARATION BY COUNTER-CURRENT ELECTROMIGRATION IN FUSED SALTS.** (to Commissariat à l'Energie Atomique). French Patent 1,216,418. Nov. 30, 1959.

The improvement consists in lowering the m.p. of the fused medium by the addition of a second salt, the ions of which have about the same mobility as the ions of the salt that is to be electrolyzed, and recycling the deposited anionic element through the cathode compartment in such a manner as to prevent the deposition of the metal. The apparatus and method are described for separating lithium isotopes, utilizing a fused medium of 70% LiBr and 30% KBr. (NPO)

**32418 ISOTOPE SEPARATOR GIVING A DOUBLE MAGNETIC DEVIATION.** (to Centre National de la Recherche Scientifique). French Patent 1,239,388. July 18, 1960.

An apparatus is described for electromagnetically separating isotopes in which a diaphragmed ion beam is subjected to a homogeneous magnetic field, passed through a second diaphragm, subjected to an inhomogeneous magnetic field, and finally passed through a third diaphragm. The separator is suitable for separating radioactive isotopes. (NPO)

**32419 METHOD OF MANUFACTURING CELL ELEMENTS FOR ISOTOPE SEPARATION PLANTS.** Ch. Nicollier. French Patent 1,248,092. Oct. 31, 1960.

Barriers for gaseous diffusion plants are manufactured by subjecting polytetrafluoroethylene tubes to the action of an electric field that has a very high intensity; this section results in a micro-perforation of the tubes. Details are not given. (NPO)

# MATHEMATICS AND COMPUTERS

**32420** (APEX-608) MULTIGROUP, MULTIREGION, ONE-SPACE-DIMENSION PHOTON-DIFFUSION THEORY CALCULATION—PROGRAM FN-GAMMA (ANP PROGRAM NO. 728). Mary S. Ferry (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Apr. 11, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 148p.

Program FN-GAMMA solves the one-dimensional, energy-dependent diffusion equation in order to compute gamma heating. The program was designed to read eleven-group cross sections from the Reactor Photon Data Tape and process them into regional compositions. Limited use of the program indicates that it is useful for computing gamma heating rates in a reactor core. (auth)

**32421** (APEX-609) CONVERSION OF PROGRAM F-N TO THE IBM-7090 (ANP PROGRAM NUMBER 308). F. D. Wenstrup (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). May 10, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 72p.

In converting Program F-N for multigroup analysis of multiregion reactor to the IBM-7090 digital computer, several modifications were made to the earlier IBM-704 version. These changes include a revised iteration sequence and new definitions for some of the control input data. Those changes which affect the successful running of the code are described. A listing of the FORTRAN-II source deck is provided. (auth)

**32422** (APEX-610) SHIELDING COMPUTING PROGRAM 20-0. J. E. MacDonald and J. T. Martin (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). May 8, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 102p.

Program 20-0 was developed to generate and write on tape source-particle parameters to be used as input for Monte Carlo shield program 18-0 designed for analysis of reactor-shield assemblies of interest to GE-ANPD. Source particles are generated in source tubes defined by right circular cylinders with mutually parallel axes of symmetry. A special case arises when the entire reactor is treated as a single source tube. The case of a point source can also be handled. Source particle spatial coordinates are chosen from appropriate power and power density distributions by one of two methods; a random method based on uniformly distributed random numbers, and a systematic method that determines the number of source particles to be started from specified volume elements. The systematic method is the only method that can be used for the special case of a single source tube. The energy of each source particle is chosen by a random method from an energy spectral distribution that is space dependent. Provision is made in the program for splitting on region and energy to conform to the demands of Program 18-0. Program 20-0 is coded for use on an IBM-704 having 32,768 magnetic core memory locations. Five magnetic tape units are used by the program. (auth)

**32423** (APEX-618) SYMBOLIC MATRIX TRANSLATOR GE-ANPD PROGRAM FLOCO-V FIELD-TEST FORMULATION. B. H. Duane (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Mar. 2, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 72p.

The FLOCO-V Symbolic Matrix Translator is a parallel-logic load-and-go assembly and transmission program evolved in formulating the machine analysis of multienergy

transport theory for the IBM-7090 Data Processing System. The capabilities of this compact (67-card) deck which motivated its development include: full utilization of both dual-channel and dual-buffer parallel logic on all input and output transmission; full utilization of automatic channel trapping on all transmission errors, with inclusion of automatic re-try and erasure corrective measures; mixed-mode loading flexibility; automatic transmission and conversion of matrix arrays having as high as twenty-two input-and-access indices and seven output indices; symbolic-binary intermediate assembly—combining symbolic block dimensionality, symbolic addressing, symbolic decrementation, and symbolic operation at the object problem level with fast binary-tape loading, fast final assembly involving no table search, full-density memory packing, and complete load-and-go modification flexibility; automatic output labelling; asynchronous accrual and buffered binary-tape output of peripheral-punch card images; parallel-logic binary transmission routine, under automatic error control, designed for high-speed iterative tape storage and core loading; and predecessor compatibility, to avoid source-program obsolescence. (auth)

**32424** (APEX-635) THE STATISTICAL EVALUATION OF RANDOM NUMBER GENERATING SEQUENCES FOR DIGITAL COMPUTERS. R. G. Herrmann (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). July 12, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 103p.

The random variables so frequently used in Monte Carlo digital computer programs are expressed in terms of random numbers uniformly distributed over the unit interval. For computational economy, these numbers are internally generated. However, the deterministic nature of such sequences (once initialized) suggests the possibility of statistical bias which might adversely affect the outcome of these programs. Any such bias is characterized by the deviation of an appropriate statistic, defined over the sequence, from its expected value. A number of classical tests, specialized for the uniform distribution over [0,1], and an associated IBM 7090 program are described. A summary is also made of the most widely used random number generating procedures. (auth)

**32425** (APEX-661) COMPRESSIBLE FLOW NETWORK COMPUTER PROGRAM (ANP-622). S. C. Skirvin (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). July 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 242p.

The bulk of the analysis and all of the coding (mostly Fortran) are presented for the Compressible Flow Network program for the IBM 704 and IBM 7090 digital computers. This program will calculate the flow distribution in non-isothermal networks containing up to 55 branches, up to 40 internal junctions where two or more branches combine, and up to 30 external junctions which are connected to external pressure levels and to sources and sinks for flows. Boundary conditions are tailored to nuclear heat transfer design but the subroutine structure of the program is such that adaptation to other types of design constraints can readily be made. The program requires a computer with a 32K memory, floating point hardware, and a tape transport unit for temporary storage of binary data. (auth)



**32426** (APEX-662) INCOMPRESSIBLE FLOW NETWORK SUBROUTINE FLONET, ANP PROGRAM NO. 604. J. A. Delaney (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Apr. 26, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 41p.

The ANP digital computer program No. 604, subroutine FLONET is documented. The routine will solve an incompressible flow network problem using the method developed by H. N. Cantrell and G. O. Mueller. The subroutine was written as a Fortran II subroutine and may be employed on both the 704 and 7090, by using the output routine for the proper machine. The subroutine is written to be independent of calling program dimension statements. (auth)

**32427** (APEX-706) FLEXIBLE MONTE CARLO PROGRAMS FMC-N AND FMC-G. J. J. Loechler and J. E. MacDonald (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Apr. 28, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 178p.

Flexible Monte Carlo programs FMC-N and FMC-G (GE-ANPD Programs 516 and 515) are digital computer programs which apply Monte Carlo methods to simulate neutron and gamma ray life histories, respectively, in a source-shield configuration. The programs were designed for flexibility in the geometrical, material, nuclear, and source descriptions of source-shield configurations and variance reduction techniques. The programs were also designed to optimize the use of fast memory and to provide complete freedom in the dimensions of the various input quantities. The programs are coded for an IBM-704 computer with a fast memory capacity of 32,768 storage locations and eight magnetic tape units, and for an IBM-7090 computer with a fast memory capacity of 32,768 storage locations and ten magnetic tape units on two data channels. No magnetic drum storage is necessary for either computer. (auth)

**32428** (APEX-708) IBM-7090 PROGRAMS TO COMPILE AND MODIFY A NUCLEAR DATA TAPE. R. G. Herrmann, T. A. Hoffman, F. D. Wenstrup, and A. Wilcox (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). May 31, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 306p.

The Reactor Nuclear Data Tape Programs were designed to compile and/or modify a nuclear data library tape from basic nuclear cross-section input. It is intended that this cross-section library tape will be utilized to provide up-to-date nuclear data for various reactor codes. Program RNDP was designed to compile an initial tape from certain minimal input data, or to add or delete complete blocks of data from an existing tape. Program RNDM was designed to compile and add to an existing tape macroscopic cross section data consisting of mixtures of microscopic cross sections available on the tape. Program RNDG was designed to modify and copy an existing tape, or to compile a new tape from sets of binary cards punched by Program RNDP. These programs were written using the FORTRAN-II system of automatic coding for the IBM-7090. (auth)

**32429** (GA-2316) MATHEMATICAL ANALYSIS OF WIRE DRAWING. T. Trozera and J. E. Dorn (General Atomic Div. General Dynamics Corp., San Diego, Calif.). July 28, 1961. Contract AT(04-3)-167. 12p.

A mathematical analysis was made of wire drawing. The basic equations were documented and a possible procedure of analysis was suggested. The problem concerned the drawing of cylindrical stock through a conical die without extension. Equilibrium equations, boundary conditions,

strain rates, constancy of volume, work-hardening, and stress-strain-rate relationship are discussed. A complete description of the stress state during drawing was obtained from a grid analysis. (M.C.G.)

**32430** (JINR-D-781) KVAZISREDNIE V ZADACHAKH STATISTICHESKOI MEKHKANIKI. (Quasi-averages in Problems of Statistical Mechanics). N. N. Bogolyubov (Joint Inst. of Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1961. 123p.

Quasi-averages of Green's functions constructed from ordinary averages, degeneration of statistical equilibrium states, principle of weakened correlations, and particle pair states are considered.  $1/q^2$ -type properties in the theory of the superfluidity of Bose and Fermi systems, the properties of basic Green functions for a Bose system in the presence of condensate, and a model with separated condensate are analyzed. (R.V.J.)

**32431** (KAPL-M-DCS-5) SPECIFICATIONS FOR TIMBAC II. D. C. Sherman (Knolls Atomic Power Lab., Schenectady, N. Y.). Sept. 1, 1961. Contract W-31-109-Eng-52. 34p.

Specifications are presented for a generalized TIMBAC-TRANSAC 2000 program for activation data reduction and power distribution estimates. Spectrum effects, data reduction, error analysis, volume integrated power and fuel densities, preliminary data treatment, and an auxiliary program are discussed. Input and output are described. (M.C.G.)

**32432** (KAPL-M-EC-6) GALS--GENERALIZED ANALYSIS OF LINEAR SYSTEMS. Donald G. Dight and James A. Warrington (Knolls Atomic Power Lab., Schenectady, N. Y.). July 15, 1961. Contract W-31-109-eng-52. 110p.

A generalized analysis of linear systems (GALS) is presented for the Philco 2000 digital computer. The program can be used to calculate the equivalent system polynomial fraction, the frequency response (Bode and Nyquist coordinates), root loci data, and the transient response for a system described in transfer function notation. (J.R.D.)

**32433** (SCR-440) BIT RATE GENERATOR AND RAW DATA CONDITIONER. S. C. Steely (Sandia Corp., Albuquerque, N. Mex.). Sept. 1961. 14p.

A phase lock loop system was utilized to derive bit rate frequency and phase from a nonreturn to zero PCM signal under adverse signal-to-noise ratios. This information was derived by having a phase lock loop locked to the bit rate. This "a priori" knowledge of time and phase of possible bit change was utilized by sampling pulses which occurred in each bit interval. By using appropriate pulse width and pulse delay circuits, the timing and width of the sampling pulses could be optimized for low signal-to-noise ratios. A qualitative description is presented of the bit rate generator and raw data conditioner. A comparison was made between the operation of this phase lock loop and the general operation of a conventional phase lock loop. Included is a description of the testing technique and possible sources of error. (auth)

**32434** (TID-13677) TECHNICAL PROGRESS REPORT. PART I. HIGH-SPEED COMPUTER PROGRAM. PART II. CIRCUIT RESEARCH PROGRAM. PART III. SWITCHING CIRCUIT THEORY. PART IV. DATA REDUCTION METHODS. PART V. ILLIAC USE AND OPERATION. PART VI. IBM 650 USE AND OPERATION. PART VII. GENERAL LABORATORY INFORMATION. (Illinois Univ., Urbana. Digital Computer Lab.). May 1961. Contract AT(11-1)-415. 47p.

Progress is reported on the design and construction of a high-speed computer; on a computer circuit research program; on theoretical aspects of computer switching circuits; and on methods for automatic reduction of data from bubble chamber photographs. The operations of the Iliac machine and an IBM 650 computer are reviewed. (T.F.H.)

**32435** (AEC-tr-4439) METHODS OF A. M. LYAPUNOV AND THEIR APPLICATION. V. I. Zubov. Translated from *Metody A. M. Lyapunova i ikh Primenenie* (a publication of the Publishing House of Leningrad University, 1957). 238p.

Results obtained in the theory of stability of motion are summarized. The theory was developed in such a manner as to make it applicable both to the solution of stability problems in the case of ordinary differential equations and in the case of systems of partial differential equations. Topics covered include stability of invariant sets of a dynamic system in metric space, stability of motion for systems of ordinary differential equations, the vicinity of the trivial solution of the differential equations with the aid of Lyapunov's first method, stability of invariant sets of general systems, and stability problem for a system of partial differential equations. (M.C.G.)

**32436** ON THE ANALYTIC PROPERTIES OF THE 4-POINT FUNCTION IN PERTURBATION THEORY. Alfred Chi-Tai Wu. Kgl. Danske Videnskab. Selskab, Mat.-fys. Medd., 33: 1-88(1961). (In English)

Analytic properties of the 4-point function as a function of 6 complex invariants are studied in simplest perturbation theory examples. This is a generalization of the work by Källén and Wightman on the vertex function. The singularity manifolds are: one 4-point singularity manifold, 4 sets of the 3-point manifolds of the type discussed by KW, and 6 cuts. These are determined in three different ways, including an explicit evaluation of the 4-fold Feynman parameter integral which results in a sum of 192 Spence functions. It is shown from the existence of the non-trivial geometric envelopes that the regularity domain  $D_4^{\text{pert}}$  is in general not entirely bounded by the analytic hypersurfaces. The boundary of the domain is illustrated with the aid of the 1-mass surfaces in some typical configurations of the 6 complex variables, showing that the 4-point boundary will in general carve out bubble singularities from the 3-point boundary. It is hoped that the results here may give some insight into the problem of finding the envelope of holomorphy of the 4-point domain determined by the axioms of the local field theory alone. (auth)



# METALS, CERAMICS, AND OTHER MATERIALS

## General and Miscellaneous

**32437** (AD-259000) PLASTICS. An ASTIA Report Bibliography. (Armed Services Technical Information Agency, Arlington, Va.). Aug. 1961. 698p.

References pertaining to plastics were selected from all unclassified documents cataloged by ASTIA from 1953 through 1960. The subject content is presented under the following headings: acrylics, adhesives, cellulose, coatings, elastomers, expanded plastics, epoxides, fibers and textiles, fluoroplastics, heat resistant polymers, laminates, optical plastics, phenolics, polyesters, polyethylenes, polymer solutions, polymers, polystyrenes, resins, silicon base, vinyls, general and miscellaneous. 3926 refs. (auth)

**32438** (AECL-1326) A.E.C.L. SPECIFICATIONS ON ZIRCONIUM PRODUCTS. Includes Specifications: MET-52. ZIRCONIUM ALLOY INGOT. Apr. 1961. MET-54. ZIRCONIUM ALLOY WARE. Mar. 1961. MET-56. ZIRCONIUM ALLOY TUBING FOR FUEL SHEATHING. Sept. 18, 1961. MET-59. ZIRCONIUM ALLOY SHEET AND STRIP. May 1961. MET-62. ZIRCONIUM ALLOY BAR AND ROD. Apr. 1961. (Atomic Energy of Canada Ltd., Chalk River, Ont.). 26p.

The specifications are outlined for Zircaloy-2 and nickel-free Zircaloy-2 shapes for use in fabrication of nuclear reactor components. The specifications are presented in terms of: scope, process, conditioning, chemical composition, mechanical properties, non-destructive testing, inspection, certification, and shipping. (B.O.G.)

**32439** (AFOSR-786) BIBLIOGRAPHY ON MOLTEN SALTS. Second Edition. Technical Report No. 2. George J. Janz (Rensselaer Polytechnic Inst., Troy, N. Y.). [1961]. Contract AF49(638)-978. 179p. (AD-258774)

A bibliography is presented of references pertaining to molten salts and high-temperature chemistry. The references are arranged alphabetically by author and chronologically from 1833 through 1960. An author index is included. (B.O.G.)

**32440** (DMIC-Memo-131) REVIEW OF RECENT DEVELOPMENTS IN THE TECHNOLOGY OF HIGH-STRENGTH STAINLESS STEELS. D. A. Roberts (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Oct. 13, 1961. 5p.

A summary is presented of developments in the technology of high-strength stainless steel and related alloys as disclosed to DMIC from July through September, 1961. (B.O.G.)

**32441** (AEC-tr-4467) THERMAL CYCLING EQUIPMENT AND EXPERIMENTAL DATA ON URANIUM. STUDIES ON URANIUM FUEL ELEMENT. PART I. Kiyooki Taketani. Translated from J. At. Energy Soc. Japan, 1: 190-5 (1959). 15p.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 14, abstract no. 2679.

**32442** A METALLOGRAPHIC TECHNIQUE FOR URANIUM DIOXIDE. A. Bassi (CISE, [Milan]). *Energia nucleare* (Milan), 8: 537-8 (Aug. 1961). (In English)

A polishing and chemical etching technique is presented which, besides reducing the effect of straining, satisfies from a metallographic viewpoint operation simplicity, reproducibility of results, and time saving and optimum

etching conditions. The technique involves light grinding, under strong flow of water, over silicon carbide paper and polishing with diamond paste. White spirit is used throughout the process as the lubricant. (N.W.R.)

**32443** PLUTONIUM AND ITS METALLURGY. A STAGE IN ITS DEVELOPMENT: THE INTERNATIONAL CONFERENCE ON THE METALLURGY OF PLUTONIUM (GRENOBLE, APRIL 1960). E. Grison (Centre d'Etudes nucleaires, Saclay, France). *Mém. sci. rev. mét.*, 58: 2-10 (Jan. 1961). (In French)

A discussion is given on physical properties of plutonium, allotropic variations; kinetics of transformation; electrical and magnetic properties; and electronic structure of the external layers of the atom. Plutonium can be used only as nuclear fuel; it is very expensive and toxic. (auth)

**32444** PREPARATION OF SMALL QUANTITIES OF METALLIC URANIUM BY REDUCTION OF DOUBLE FLUORIDE OF URANIUM AND CALCIUM. A. Accary, M. Albert, E. Le Boulbin (Centre d'Etudes nucleaires, Saclay, France). *Mém. sci. rev. mét.*, 58: 203-8 (Mar. 1961). (In French)

Reduction of  $UF_4 \cdot F_2Ca$  by magnesium gives metallic uranium of high purity with a yield of 99% for quantities of uranium as low as 20 g. This method is found to be easier than reduction of  $UF_4$ . (auth)

**32445** THORIUM. T. H. H. Skeet. *Mine & Quarry Eng.*, 27: No. 4, 179-84 (Apr. 1961).

The occurrences and reserves, extraction processes, and present and future applications of thorium and its compounds are discussed. The flow sheets of a concentration plant at Yoganup, Australia, and a mineral separation plant at Capel, Australia, are presented. The monazite treatment process using sulfuric acid is outlined. (N.W.R.)

**32446** CONTRIBUTIONS TO THE DATA ON THEORETICAL METALLURGY. XIV. ENTROPIES OF THE ELEMENTS AND INORGANIC COMPOUNDS. K. K. Kelley and E. G. King (Bureau of Mines, Berkeley, Calif.). *Bureau of Mines Bulletin* 592. Jan. 1960. 153p. \$0.75 (GPO).

Available entropy values at 298.15°K for the elements and inorganic compounds were assembled from data available through September 1959. Methods of calculating entropies using low-temperature heat-capacity data, spectroscopic data, molecular-constant data, and reaction entropies are discussed. The available data concerning low-temperature heat capacities and changes in state occurring in the temperature range from 0 to 298.15°K are also summarized. (M.C.G.)

**32447** COLUMBIUM METALLURGY. Proceedings of a Symposium, Bolton Landing, New York, June 9-10, 1960. D. L. Douglass and F. W. Kunz, eds. *Metallurgical Society Conferences*. Volume 10. New York, Interscience Publishers, 1961. 760p. \$26.00.

Thirty-three papers are included; separate abstracts have been prepared for thirty-two. A critical comparison of niobium with other materials is given for missile, aircraft, and nuclear applications. The following topics are given special attention: fabrication, mechanical properties, general metallurgy, oxidation, and corrosion. (N.W.R.)

**32448** SOLID-PHASE BONDING OF COLUMBIUM. S. J. Paprocki, E. S. Hodge, and P. J. Griphover (Battelle

Memorial Inst., Columbus, Ohio). p.13-30 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

A method for self-bonding niobium is discussed. Niobium components to be bonded are enclosed in an evacuated envelope or welded to form a gastight assembly. The assembly is then subjected to an inert gas pressure and heated above the recrystallization temperature of niobium. The inert gas forces the components into the intimate contact necessary for diffusion to occur. Optimum bonding is achieved at 1150°C with 10,000 psi of helium gas for a time of 3 hr. Surface preparation of the niobium was found to have a significant influence on the subsequent bond characteristics. Of the many methods that were investigated, including various chemical treatments, grit abrasion, machining, and electropolishing, treatment with a pickling solution made up of 65 parts nitric acid and 35 parts hydrofluoric acid consistently resulted in satisfactory bonding. Since the process involves the direct solid-phase self-bonding of niobium surfaces, the embrittlement that sometimes results during brazing or fusion welding is avoided. The bonds exhibit grain growth across the original bond interface and a ductility comparable with the base niobium prior to bonding. Mechanical properties as evaluated by bend and tensile tests also show no difference from the base niobium. The technique is being applied to the bonding of compartmented niobium-clad  $UO_2$  and cermet fuel elements. The basic process with only minor modifications can also be applied to the bonding of niobium alloy components of almost any shape. (auth)

**32449 EVALUATION OF FORMING CHARACTERISTICS OF COLUMBIUM ALLOYS.** R. T. Torgerson (Boeing Airplane Co., Seattle). p.31-52 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

Forming characteristics of five niobium alloy sheet materials proposed for hypersonic vehicle structures were evaluated by studies of tensile properties, bend ductility, biaxial ductility, brittle-ductile bend transition temperature, and embrittling effects resulting from diffusion of interstitial elements. Results show good room temperature formability with brittle-ductile bend transition at sub-zero temperatures. No improvement in formability was found for the test alloys at elevated temperatures. Oxygen diffusion hardening and embrittlement were the principal effects of atmospheric contamination for a range of temperatures and atmospheres. Preliminary data indicate a promising combination of strength, formability, and sub-zero transition temperature for the experimental alloy, high interstitial Nb-33Ta-0.75Zr. (auth)

**32450 INFLUENCE OF CARBON ADDITIONS ON THE WORKABILITY AND MECHANICAL PROPERTIES OF COLUMBIUM.** R. T. Begley and A. I. Lewis (Westinghouse Electric Corp., Pittsburgh). p.53-74 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

The effect of carbon additions on the microstructure, hardness, workability, and low temperature tensile properties were evaluated. Metallographic examination indicated that the maximum solubility of carbon in niobium was between 0.75 and 1.0 wt % at 2230°C. A hardness peak was observed in niobium containing about 0.038 wt % carbon. The anomalous hardness maximum appears to be associated with the presence of a sub-boundary network. Carbide distribution significantly influenced workability. Cold workability was greatly reduced when carbides formed grain boundary networks. Carbon additions up to 0.53 wt % had no effect upon the yield strength of niobium in the temperature range -196° to 200°C, but significantly reduced low temperature ductility. (auth)

**32451 FABRICATION OF COLUMBIUM ALLOY CASTINGS AT LOW TEMPERATURES.** J. A. DeMastry and E. L. Foster (Battelle Memorial Inst., Columbus, Ohio). p.75-83 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

A recent development in fabrication techniques has resulted in successful initial breakdown of cast structures of consumably melted ingots of niobium-chromium, niobium-molybdenum, niobium-zirconium, niobium-titanium-chromium, and niobium-titanium-molybdenum alloys at 1000°F by upset forging. Further refinement of this technique has allowed breakdown of cast structures of niobium-molybdenum and niobium-titanium-chromium alloys at room temperature. This fabrication is discussed in detail and the alloys to which this technique is applicable were predicted. (auth)

**32452 EFFECT OF VARIOUS GASEOUS CONTAMINANTS ON THE STRENGTH AND FORMABILITY OF COLUMBIUM.** H. E. McCoy and D. A. Douglas (Oak Ridge National Lab., Tenn.). p. 85-118 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

Stress-rupture tests were run on pure niobium at 982 and 1010°C in environments of high purity argon, wet argon, nitrogen, wet hydrogen, and dry hydrogen. The creep rate was decelerated by the presence of nitrogen and accelerated by environments in which hydrogen or water vapor were present. Although the rupture ductility was not reduced by the latter environment, the room temperature ductility was seriously reduced if the specimen was cooled in the test environment. Tensile and creep tests, run at 982°C on specimens to which controlled additions of  $O_2$  up to 0.2 wt % were made, indicate that the strength of pure niobium is increased by oxygen without seriously reducing the ductility. Room temperature tensile tests on specimens containing up to 0.15 wt %  $O_2$  indicate similar results. Room temperature bend tests on specimens having undergone a variety of heat treatments in environments of nitrogen, oxygen, and hydrogen indicate that contamination picked up during heat treatment may cause problems in subsequent low temperature deformation processes. A limited amount of data is presented which relate to the aging reaction which occurs in the Nb-1 Zr alloy. Aging in this alloy is correlated with the  $O_2/N_2$  ratio of the material and may also be influenced by the  $O_2/C$  ratio. Oxygen is observed to inhibit the aging reaction and a mechanism is postulated. (auth)

**32453 OXIDATION RESISTANCE OF ALUMINUM DIP COATED (ALDICO) COLUMBIUM ALLOYS.** Robert G. Carlson (General Electric Co., Cincinnati). p.119-37 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

Oxidation resistance of niobium alloys can be enhanced by surface coating with certain elements such as aluminum. In these studies the effectiveness of a 15% silicon-aluminum dip coating on F-48, F-50, Fansteel 82, 7.5% titanium-5% molybdenum, and 8% titanium alloys by varying the time (1 to 13 min) and temperature (815 to 1150°C) of dip and the post-treatment was evaluated. The results indicate an optimum dip time and temperature and post-treatment to be, respectively, 3 min at 925°C and a treatment in vacuum for 1 hr at 1040°C. The activation energy of this growth was determined to have a comparatively low value of approximately 20 kcal/mole. (auth)

**32454 CARBON-OXYGEN RELATIONSHIP IN SINTERED COLUMBIUM.** E. M. Grala (Lockheed Missiles and Space Div., Sunnyvale, Calif.) and R. J. Van Thynne.



p.139-45 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

Niobium powder normally contains an undesirably high oxygen content, and purification during sintering may be enhanced by small carbon additions. The residual carbon-oxygen balance in sintered material was investigated as a function of various mole ratios of carbon to oxygen in the starting powder. This investigation was limited to low impurity levels since information on reactions between niobium oxide and niobium carbide is available in the literature. The niobium powder containing 0.35 wt % oxygen and 0.01 wt % carbon was only slightly improved by a standard annealing treatment at 2000°C for 1 hr at pressures under one micron. Increasing carbon additions resulted in lowered oxygen levels with no increase in carbon content of the sintered product up to the stoichiometric composition required to form carbon monoxide. At higher carbon contents the oxygen was lowered further, but residual carbon increased appreciably. Nitrogen and tantalum contents were unchanged, and the density of the sintered compacts was constant. (auth)

**32455** PILOT QUANTITIES OF COLUMBIUM-BASE ALLOYS BY VACUUM ARC MELTING. S. J. Noesen (General Electric Research Lab., Schenectady, N. Y.). p.147-72 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

Niobium base alloys F-48 and F-50 were prepared successfully as 100-lb ingots by a single melt in the vacuum arc-melting furnace. A description is given of the raw materials used and of the method by which the consumable electrodes were fabricated. Melting conditions are described, including the power requirements to produce a 6-in. diameter ingot, i.e., 8000 amp at 30 to 40 v. Information concerning the removal of interstitial contaminants and the loss of alloying elements during melting is presented. The macrostructure of the arc cast ingots is typically columnar, although the grain size is much finer than that usually produced in pure refractory metals. The microstructure is strongly dendritic. Results of solution treatments of the cast structure performed in an effort to reduce the degree of coring in the dendritic structure are presented. The methods by which the ingots are prepared for subsequent fabrication are also presented. (auth)

**32456** THE PROPERTIES OF COLUMBIUM-TITANIUM-TUNGSTEN ALLOYS. PART I. OXIDATION. S. T. Wlodek (Union Carbide Metals Co., Niagara Falls, N. Y.). p.175-203 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

The exploitation of the niobium-titanium-tungsten system allows the design of niobium-rich alloys combining high mechanical properties and oxidation resistance to 1400°C. The maximum in oxidation resistance, which occurs at 5 to 15 wt % titanium and in excess of 15 wt % tungsten, is associated with the formation of a  $\text{Nb}_2\text{O}_5 \cdot \text{TiO}_2 \cdot \text{WO}_3$  type of niobate. Although alloys such as 65% Nb-7% Ti-28% W can exhibit a fiftyfold to one-hundredfold reduction in the oxidation rate of pure niobium at temperatures up to 1425°C, they are sensitive to oxygen contamination. The effect of quaternary and quinary additions of beryllium, chromium, iron, molybdenum, vanadium, and zirconium is presented in relation to the kinetics of gross oxidation, sub-scale contamination, and nature of the oxidation products. In this manner, the oxidation kinetics of alloys such as 67% Nb-10% Ti-20% W-3% V and 70% Nb-7% Ti-20% W-3% Mo, which partially retain the oxidation resistance of the ternary base while exhibiting improved resistance to oxygen contamination, are outlined. (auth)

**32457** THE PROPERTIES OF COLUMBIUM-TITANIUM-TUNGSTEN ALLOYS. PART II. STRUCTURE AND MECHANICAL PROPERTIES. W. F. Sheely and J. L. Wilson (Union Carbide Metals Co., Niagara Falls, N. Y.). p.205-19 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

Tensile properties of a 65% Nb-7% Ti-28% W alloy, which combines good high temperature strength and oxidation resistance, are described. Effects on high temperature strengths of Nb-Ti-W alloys of 3% additions of molybdenum or vanadium and 1 to 2% zirconium were investigated; molybdenum and zirconium can contribute to high temperature strength, but the strengthening by vanadium is impaired by the presence of titanium. The influences of heat treatment on hardness and high temperature strengths of Nb-Ti-W alloys were considered, and it was found that heat treatments which altered carbide distribution had important effects on properties. (auth)

**32458** THE FABRICATION AND MECHANICAL PROPERTIES OF SOME COLUMBIUM ALLOYS FOR USE IN PRESSURIZED WATER REACTORS. D. J. Maykuth and R. I. Jaffee (Battelle Memorial Inst., Columbus, Ohio). p.223-56 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

A number of binary and ternary alloys of interest in an alloy development program for pressurized-water reactor applications were prepared, using an electron-beam-refined niobium base, by arc melting, and fabricated to sheet. The comparative fabricabilities of these alloys and their hardnesses, tensile, creep, and stress-rupture properties at temperatures up through 1500°F are discussed. (auth)

**32459** STRAIN AGING EFFECTS IN COLUMBIUM DUE TO HYDROGEN. B. A. Wilcox (Materials Central, Wright-Patterson AFB, Ohio) and R. A. Huggins. p.257-78 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

The strain aging tendencies of recrystallized, fine-grained arc cast niobium were investigated using two different experimental techniques, the feasibility and accuracy of both methods having first been evaluated by tests on 1020 steel. Tensile straining (up to about 1% strain) at -50°C revealed the characteristic upper and lower yield point found in bcc metals, this effect being attributed to locking of dislocations by atmospheres of interstitial atoms. Immediate re-straining of the samples showed no yield point effect since the dislocations were already unpinning, but suitable aging treatments (121 to 260°C) caused the yield point to return as a result of dislocations being relocked. The aging temperature dependence of the rate of yield point return was evaluated, and an activation energy of 10,500 cal/mole was determined for the process. The ability of hydrogen to cause dislocation pinning in niobium was further substantiated by using dynamic modulus measurements to study the strain aging process. Samples of Nb from the same heat as those used in yield point return studies, and samples which were hydrogen charged at 650°C for 7 hr were deformed 2 to 3% in compression. The dynamic modulus (measured at room temperature) was decreased as a result of dislocation unpinning during deformation but increased toward the original unstrained value as a result of aging at temperatures from 24 to 97°C. Activation energies for the strain aging process were determined for the uncharged and the hydrogen-charged material ( $Q = 7830-8280$  cal/mole uncharged;  $Q = 8080-9920$  cal/mole, hydrogen charged). While hydrogen charging did not have a very large effect on the activation energy, the treatment did cause a fourfold increase in the frequency

factor A of the empirical rate equation  $\text{rate} = Ae^{-Q/RT}$ . It was further noted that the hydrogen-charging treatment greatly embrittled the niobium. The reduction in area of tensile samples tested at 24°C and a strain rate of 0.005  $\text{min}^{-1}$  was decreased from 79 to 2% as a result of hydrogen charging. (auth)

**32460 PROCESSING AND PROPERTIES OF F-48 COLUMBIUM ALLOY SHEET.** T. K. Redden (General Electric Co., Evendale, Ohio). p.279-98 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

The metal processing procedures and mechanical properties of a 15 wt % tungsten-5 wt % molybdenum-1 wt % zirconium niobium alloy (designated F48) are described. Ingot conversion procedures are described in some detail with particular emphasis on the techniques necessitated by the nature of niobium base alloys. Sheet in a thickness range of 0.040 to 0.050 in. was produced and was used for determination of mechanical properties. Tensile properties to 1371°C are given, together with stress rupture tests at 1093, 1204, and 1371°C. The recrystallization behavior and bend properties of the sheet are described and discussed. The reported mechanical properties show useful engineering strength to at least 1370°C. (auth)

**32461 YOUNG'S MODULUS OF COLUMBIUM AT ELEVATED TEMPERATURES.** David P. Laverty (Thompson Ramo Wooldridge, Inc., Cleveland) and Edward B. Evans. p.299-307 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

Young's modulus of high purity niobium was determined by a static test method over a temperature range from room temperature to 820°C. Annealed sheet was stressed in axial tension under a protective atmosphere of argon, and the resulting elastic strain was read directly by optical means. The modulus decreased linearly from 16.2 million psi at room temperature to 14.1 million psi at 820°C. (auth)

**32462 MECHANISMS OF CREEP IN COLUMBIUM AND COLUMBIUM-1% ZIRCONIUM ALLOY.** D. P. Gregory and G. H. Rowe (Pratt & Whitney Aircraft Div., United Aircraft Corp., Middletown, Conn.). p.309-41 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

The mechanisms of creep in pure niobium and niobium-1% zirconium alloy were studied in the temperature range  $0.33 < T/T_m < 0.53$  using activation energy and slip marking studies. Experimental data were interpreted by extension of dislocation theory for bcc metals. A low activation energy recovery process which significantly affects mechanical behavior of bcc metals is described and utilized in the development of the creep theory. The rate-controlling process for creep in niobium and niobium-1% zirconium alloy changes from a slip-controlled mechanism to a diffusion-controlled mechanism at temperatures of 930 and 1100°C, respectively. (auth)

**32463 EFFECT OF GRAIN SIZE, STRAIN RATE, AND TEMPERATURE ON THE YIELD STRENGTH OF COLUMBIUM.** E. S. Tankins (Naval Air Material Center, Philadelphia) and R. Maddin. p.343-63 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

The yield stress of solid state purified niobium was evaluated in the temperature range 298 to 90°K as a function of grain size and strain rate. A discontinuous yield point was observed in the temperature range 298 to 210°K. Below 200°K, the yield point is no longer continuous. The discontinuous yield point observed above 200°K is typical of other bcc metals. (auth)

**32464 COLUMBIUM-NITROGEN SYSTEM.** Rodney P. Elliott and Steven Komjathy (Illinois Inst. of Tech., Chicago).

p.367-82 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

The niobium-nitrogen equilibrium diagram is investigated in the composition range up to stoichiometric NbN and in temperatures up to the melting point of Nb. When niobium is melted in a nitrogen atmosphere or when niobium powder is melted, an alloy composition of approximately 3 wt % nitrogen is established. Metallographic examination of the arc-melted ingots does not reveal the nature of the melt reaction but indicates the precipitation of Nb<sub>3</sub>N from the solid solution on cooling. The boundary of the niobium-nitrogen solid solution is established by direct chemical analysis. The solubility is found to be 0.25 wt % N at 1200°C and 2.5 wt % at 2400°C. X-ray diffraction of niobium powder was used to reveal the existence of the intermediate phases. The existence of the close-packed hexagonal Nb<sub>3</sub>N, tetragonal NbN (Nb<sub>4</sub>N<sub>3</sub>), face-centered cubic NbN, and hexagonal NbN is confirmed. On the basis of the accumulated information a condensed Nb-N phase diagram is proposed that incorporates the observed equilibrium phenomena. (auth)

**32465 ALLOYING BEHAVIOR OF COLUMBIUM.** A. E. Dwight (Argonne National Lab., Ill.). p.383-406 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

Niobium phase diagrams may be classified into three groups: those which exhibit liquid or solid immiscibility, those which exhibit continuous solid solubility, and those which form compounds. The nature of the diagram assumed by a particular element is closely related to its position in the periodic table. Data are presented on binary systems which are representative of all three groups. The Nb-Zr-U and Nb-Ti-Mo ternary systems are used to illustrate alloy behavior trends. A study was made of the factors which control the occurrence of five families of Nb compounds, designated by their prototypes or names established by use as Cr<sub>3</sub>O, sigma, Laves,  $\alpha$ -Mn (or chi) and AB<sub>3</sub>. The last, not strictly a family, includes Cu<sub>3</sub>Au, TiAl<sub>3</sub>, and TiCu<sub>3</sub> types. It was found that phases occur from left to right in the following order: bcc  $\rightarrow$  Cr<sub>3</sub>O  $\rightarrow$   $\sigma$   $\rightarrow$  Laves  $\rightarrow$   $\alpha$ -Mn  $\rightarrow$  cp hexagonal variant  $\rightarrow$  fcc variant. No one system thus far known contains all these phases, but the order of occurrence is always followed. (auth)

**32466 RECOVERY AND RECRYSTALLIZATION OF COLUMBIUM-1.0% ZIRCONIUM ALLOY.** J. R. Stewart, W. Lieberman, and G. H. Rowe (Pratt & Whitney Aircraft Div., United Aircraft Corp., Middletown, Conn.). p.407-34 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

A Nb-1 Zr alloy was cold rolled to 0.060 in. thick sheet with reductions of 20, 40, 60, 80, and 95% after process annealing at 1200°C. Recovery and recrystallization characteristics were determined as a function of per cent cold reduction. In general, behavior followed classical theory in that increasing cold work resulted in decreasing temperature for initiation of recovery and recrystallization. Room temperature and elevated temperature properties were also determined as a function of degree of cold work in both the as-worked condition and as-annealed at 1200°C. Tests in the as-cold-worked condition showed that the elevated temperature yield strength decreased and primary creep rate increased with increasing cold work. Annealing at 1200°C did not significantly change the yield strength but did lower the primary creep rate. The best combination of properties was obtained by a 1200°C anneal following a cold reduction of 20 to 40%. A short discussion is included relating the recovery and recrystallization process to dislocation theory. (auth)



**32467 THE RECRYSTALLIZATION BEHAVIOR OF COLUMBIUM-VANADIUM ALLOYS.** B. S. Shabel, F. W. Kunz, and D. L. Douglass (Knolls Atomic Power Lab., Schenectady, N. Y.). p.435-58 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

The recrystallization of several Nb-V alloys cold-rolled 10, 50, and 90% was studied by x-ray, hardness, and metallographic techniques. The activation energies for recrystallization after 50% reduction were determined as follows: Nb-0.6 atomic-% V-92 kcal/g-atom; Nb-1.6 atomic-% V-92 kcal/g-atom; and Nb-8.9 atomic-% V-118 kcal/g-atom. A Fourier analysis of the line broadening associated with the (110) reflection indicated that broadening was due mainly to nonuniform strains over regions of about 120 Å in the cold-worked material and that, above 900°C for 15 min annealing, an increase in the particle size contribution to the broadening was observed. Texture studies of cold-rolled sheet indicated a texture described by the (100) (011), (112) (110), and (111) (112) orientations. The recrystallized texture of the Nb-0.6 atomic-% V alloy was observed to be (100) (011), (111) (112) whereas the Nb-3.5 atomic-% V and Nb-8.9 atomic-% V alloys had a greater retention of the (112) (110) component after recrystallization. (auth)

**32468 THE FLOW AND FRACTURE CHARACTERISTICS OF ELECTRON-BEAM-MELTED COLUMBIUM.** E. T. Wessel, L. L. France, and R. T. Begley (Westinghouse Electric Corp., Pittsburgh). p.459-502 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

The flow and fracture characteristics of electron-beam melted niobium were studied in the range from 600 to -269°C so as to encompass both the ductile-to-brittle transition and the strain aging temperature regions. Both tension and compression tests were conducted over the entire temperature range. The data presented are analyzed with respect to the effects of interstitial impurities, strain rate and temperature on the flow and fracture characteristics. The results are compared with previous work and are related to existing theories of flow and fracture. (auth)

**32469 MECHANICAL BEHAVIOR OF COLUMBIUM CONTAINING OXYGEN.** J. F. Enrietto (Jones & Laughlin Steel Corp., Pittsburgh), G. M. Sinclair, and C. A. Wert. p.503-21 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

Niobium is extremely susceptible to strain aging, both in tension and in fatigue when small amounts of oxygen are present in solid solution. The temperature at which maximum strain aging occurs is apparently a function of the strain rate, and for the rates used maximum strengthening occurred at 500°C in tension and 400°C in fatigue. The stress magnitude of the strain aging peak for both tension and fatigue is dependent upon the oxygen concentration. Strengthening due to strain aging increases very rapidly with increasing oxygen content up to approximately 0.02 wt % which corresponds to one oxygen atom per dislocation per atom plane in the severely deformed metal. Oxygen in excess of 0.02 wt % contributes relatively little additional strengthening at the temperature of maximum strain aging. (auth)

**32470 THERMODYNAMIC FUNCTIONS FOR THE COLUMBIUM-HYDROGEN SYSTEM.** O. M. Katz and E. A. Gulbransen (Westinghouse Electric Corp., Pittsburgh). p.523-37 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

The niobium-hydrogen system was investigated between 225 to 513°C and 0.01 to 760 mm of Hg of  $H_2$ . Interpretation

of the data was based on solid-solution behavior in this range. The relative partial molar enthalpy of hydrogen decreases from -7.59 kcal/mole of H at a mole fraction  $N_H$  of 0.035 to -10.40 kcal/mole of H at  $N_H = 0.405$ , with an inversion point at  $N_H = 0.350$ . Relative partial molar entropies of hydrogen for the same composition range decreased from -5.54 to -15.78 cal/deg-mole of H. From  $N_H = 0.035$  to 0.405 the total heat and entropy of formation decreased from -0.21 to -4.09 kcal/mole of alloy and -0.08 to -5.04 cal/deg-mole of alloy, respectively. The relative partial molar free energy for hydrogen in body-centered cubic Nb-H alloys increases with increasing composition at a given temperature and increasing temperature at a given composition. Based on the variation of enthalpy and entropy with composition: hydrogen bond strength in the lattice increases up to  $N_H = 0.325$  with the rate of increase largest in dilute solutions, hydrogen interactions increase continuously with composition and eventually cause "saturation," and at compositions approaching saturation the hydrogen bond strength decreases markedly. (auth)

**32471 CONTRIBUTION TO THE TECHNOLOGY OF BINARY COLUMBIUM ALLOYS CONTAINING MOLYBDENUM AND TUNGSTEN.** H. Braun (Metallwerk Plansee A. G., Ruetta, Tyrol, Austria), K. Sedlatschek, and B. F. Kieffer. p.539-49 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

The variation of hardness, electrical properties, chemical properties, and workability was determined for the complete range of compositions in the isomorphous binary systems Nb-Mo and Nb-W. Maxima in hardness and electrical resistivity were observed. A workability gap existed in both systems, in which region rolling or forging could not be accomplished. Niobium-rich alloys could be cold-rolled, and alloys rich in either Mo or W could be hot-rolled at temperatures above 1600°C. The addition of either Mo or W decreased the reactivity with hydrogen, approximately 50% solute being sufficient to eliminate hydride formation. The chemical properties of Nb-W alloys were dependent upon composition, 20% W representing the composition above which negligible attack in HF was measured and the composition at which attack by  $K_3Fe(CN)_6$  was a maximum. (auth)

**32472 THE PROPERTIES OF COLUMBIUM-ALUMINUM-VANADIUM ALLOYS. PART I. OXIDATION.** S. T. Wlodek (Union Carbide Metals Co., Niagara Falls, N. Y.). p.553-83 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

The addition of small amounts of aluminum and vanadium to niobium appreciably reduces the oxidation rate while retaining the inherent low neutron cross section of niobium and improving the mechanical properties. Further complexing with titanium, chromium, iron, and nickel raises the oxidation resistance of the Nb-Al-V type of alloy to the level of stainless steels. Studies of the kinetics of oxidation in the ternary Nb-Al-V system up to a maximum solute content of 10 wt % are presented for 800, 1000, and 1200°C. The effect of quaternary and quinary additions is similarly treated, and the contamination and metal loss behavior of the better alloys is outlined. By means of x-ray and petrographic examinations of the reaction products, it was possible to relate the oxidation resistance of Nb-Al-V alloys to the formation of a protective NbO layer and the absence of  $Nb_2O_5$  in the oxidation products. (auth)

**32473 THE PROPERTIES OF COLUMBIUM-ALUMINUM-VANADIUM ALLOYS. PART II. MECHANICAL PROPERTIES.** W. F. Sheely and J. L. Wilson (Union

Carbide Metals Co., Niagara Falls, N. Y.). p.585-94 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

The Nb-3% Al-3% V alloy is one of the more oxidation-resistant niobium-base ternary alloys. Techniques for consolidating and fabricating alloys based on this composition are described, and the effects of titanium and zirconium on mechanical properties are described. Zirconium increases elevated temperature strength, but while titanium improves oxidation resistance, it also decreases elevated temperature strength. (auth)

**32474** THE HIGH TEMPERATURE STEAM CORROSION OF COLUMBIUM-VANADIUM ALLOYS. H. A. Fisch, D. L. Douglass, and B. E. Dearing (Knolls Atomic Power Lab., Schenectady, N. Y.). p.597-613 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

The corrosion behavior of binary niobium-vanadium alloys containing up to 8.9 atomic-% vanadium was studied in steam over the temperature range of 360 to 482°C. The corrosion kinetics appeared to fit a cubic rate law, the rates decreasing with increasing solute. Dilute alloys, containing less than 1.2 atomic-% vanadium, formed a Nb<sub>2</sub>O<sub>5</sub> film, whereas alloys containing from 1.2 to about 3.6 atomic-% vanadium formed a duplex scale of Nb<sub>2</sub>O<sub>5</sub> and NbO<sub>2</sub>. The 8.9 atomic-% alloy formed only NbO<sub>2</sub> which accounted for the superior corrosion resistance. A mechanism was postulated which involves the partial dissociation of the lower oxide and the resultant changes in anion vacancies. (auth)

**32475** THE IGNITION OF COLUMBIUM AND SELECTED ALLOYS. J. W. Clark (General Electric Co., Evendale, Ohio). p.615-47 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

The effects of environmental parameters on the oxidation characteristics of niobium and selected alloys were investigated from 1300 to 1550°C. When the energy release due to the exothermic oxidation reaction exceeds the heat removed by conduction, convection, and radiation cooling, a spontaneous, self-propagating temperature rise occurs. This ignition is observed in dynamic oxidation of unalloyed Nb under conditions reported herein at a temperature of 1470 ± 10°C. All the data indicate that ignition of Nb and of the Mo-containing alloys is closely associated with melting of the oxide and the consequent increase in the rate of oxygen diffusion. The results indicate that the reaction rate is dependent on oxygen availability in the atmosphere; the rate of oxygen transport in static air or very low forced-flow conditions is not sufficient to support ignition. Analysis of the thermal data indicates an oxygen reaction rate of at least 30 mg/cm<sup>2</sup> sec during ignition. That the phenomenon of ignition is strongly dependent on surface-to-volume ratio was demonstrated by the fact that coated alloy specimens with intentional defects of various sizes in the coating showed no tendency toward self-propagating temperature increase upon exposure at temperatures several hundred degrees above the ignition point of the uncoated alloy. (auth)

**32476** THE OXIDATION OF COLUMBIUM AT LOW OXYGEN PRESSURES. H. Inouye (Oak Ridge National Lab., Tenn.). p.649-65 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

The oxidation of unalloyed niobium in oxygen at pressures between 3 × 10<sup>-6</sup> and 5 × 10<sup>-3</sup> mm Hg and temperatures of 850, 1000, and 1200°C proceeds principally by solution of oxygen, internal oxidation, film formation, and by an oxide-gas reaction. Characteristic rate curves for

each of the oxidation stages were found and correlated with the formation of Nb-O solid solutions, NbO, NbO<sub>2</sub>, and Nb<sub>2</sub>O<sub>5</sub>. The four oxidation stages were found to be temperature, pressure, and time dependent. Three different linear and two parabolic reaction rates were observed. The rate-controlling reactions were governed by adsorption of oxygen, diffusion of the reactants through a protective NbO<sub>2</sub> layer, and by a reaction between oxygen and NbO<sub>2</sub> to form Nb<sub>2</sub>O<sub>5</sub>. Concept of a sub-oxide layer to account for the initial protective stages and the finite linear oxidation rates associated with Nb<sub>2</sub>O<sub>5</sub> formation are substantiated by this study. (auth)

**32477** "BREAK-AWAY" PHENOMENA IN THE OXIDATION OF COLUMBIUM SINGLE CRYSTALS. R. E. Pawel, J. V. Cathcart, and J. J. Campbell (Oak Ridge National Lab., Tenn.). p.667-84 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

Oxidation rate measurements and oxide morphology studies on single crystal specimens of niobium indicated that the process of gaseous oxidation in the temperature range of 400 to 425°C is particularly dependent upon the crystallographic orientation of the metal. Specimens oriented within about 25° of (100) oxidized, at least in the initial stages, at a much slower over-all rate than was the case for the remaining orientations. These differences in oxidation characteristics were attributed in part to the effect of substrate orientation on the manner in which the transition from protective to nonprotective oxidation behavior occurred. (auth)

**32478** THE HOT WATER CORROSION RESISTANCE OF COLUMBIUM AND COLUMBIUM ALLOYS. W. D. Klopp, W. E. Berry, and D. J. Maykuth (Battelle Memorial Inst., Columbus, Ohio). p.685-718 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

Corrosion studies were conducted in 600 and 680°F water and in 750°F steam on a large number of wrought binary and ternary niobium alloys. These were prepared using either commercial or high purity niobium as the base material. High purity niobium shows a greater degree of corrosion resistance than the commercial grade. However, base-metal purity does not appear to have a significant effect on the corrosion behavior of niobium alloys. While many alloying additions improve the corrosion resistance of niobium, the effectiveness of binary titanium, zirconium, and vanadium additions and of ternary titanium and chromium combinations is outstanding. The corrosion studies were supplemented with metallographic and x-ray diffraction studies. The hot water corrosion resistance of these alloys was correlated with their resistance to oxidation in air at elevated temperatures. (auth)

**32479** OXIDATION RATE OF COLUMBIUM AS A FUNCTION OF TEMPERATURE AND PRESSURE. J. F. Brady and J. N. Ong, Jr. (Washington Univ., St. Louis). p.719-39 of "Columbium Metallurgy." New York, Interscience Publishers, 1961.

By assuming that interaction of oxygen atoms occurs in interstitial solid solution in niobium, the rate of oxidation in the temperature range 400 to 1200°C and the pressure range 1.47 to 605 psi is satisfactorily described by an equation of the form,  $\text{rate} = A' \exp \{-\Delta H/RT\} \theta^1 = k_R \theta^1$  where  $k_R$  is the specific reaction rate constant and  $\theta^1$  is the fraction of available interstitial sites on which absorption of oxygen has occurred. The relationship between pressure and  $\theta^1$  is given by  $p = [\theta^1/(1 - \theta^1)]^{-2} \exp \{2(\theta^1 - 1)2E^{ii}/kT\} D \exp \{2(E^i + E^{ii} + \frac{1}{2}E^d)/kT\}$  where  $E^{ii}$  is the interaction energy between absorbed oxygen atoms,  $E^i$  is the energy of absorption of oxygen in the metal lattice,  $E^d$



is the energy of dissociation of oxygen molecules, and  $D$  is a quantity associated with the entropy change for the process  $2O(solution) = O_2$ . Values obtained are:  $A' = 1.26 \times 10^{16}$  mg/cm<sup>2</sup> hr,  $\Delta H = 52,600$  cal/mole,  $E^{ii} = -4,600$  cal/mole,  $D = 12.5 \times 10^{24}$  psi and  $E^i + E^{ii} + \frac{1}{2}E^d = -42,950$  cal/mole. (auth)

**32480 BOARD FOR CONSTRUCTIONAL PURPOSES.** Elso Joo. French Patent 1,214,017. Apr. 5, 1960.

The board is used as a shield against radiations and comprises two outer layers connected together at their inner sides with interposition of an intermediate layer. One outer layer is constituted by mosaic plaquettes of glass or a ceramic material. The intermediate layer is provided with a plurality of cells filled with materials having a shielding action against the radiations. The cells may be prefabricated and connected to the outer layers by interposition of a glass wool layer impregnated with a plastic material having adhesive properties. (NPO)

**32481 METHOD OF PREPARING CARBON WITH A LOW PERMEABILITY.** (to General Electric Co., Ltd.). French Patent 1,234,872. May 23, 1960.

The permeability of a carbon body is decreased by degassing the body and impregnating it with a mixture of furfural and 3 to 5% furfuryl alcohol which is thickened with cellulose acetate or ethyl cellulose. The impregnant is polymerized and finally carbonized at 1000°C. (NPO)

**32482 METHOD OF PREPARING PETROLEUM COKE AND GRAPHITE.** (to Shell Internationale Research Maatschappij N. V.). French Patent 1,234,943. May 23, 1960.

A method is described for preparing petroleum coke to be converted into moderator graphite. The method consists in de-asphaltizing an asphaltic residual oil with liquid propane, blowing the purified oil at 150 to 400°C, preferably at 200 to 300°C, with 50 to 175 g O<sub>2</sub> per kg oil, and cokifying the blown oil. (NPO)

**32483 METHOD OF PREPARING ARTIFICIAL GRAPHITE.** (to United Kingdom Atomic Energy Authority). French Patent 1,242,942. Aug. 29, 1960.

Artificial graphite, having a high density and a low permeability, is prepared from a mixture of pulverized artificial graphite (particle size less than 1000 microns, but 60% having a particle size greater than 100 microns), carbon black (particle size 0.2 to 0.7 micron), and a binder. Preferred compositions are 2 parts graphite, 1 part carbon black, 21 to 23% coal tar; 3 parts graphite, 2 parts carbon black, 18 to 20% furfuryl alcohol (+ furfural). (NPO)

## Corrosion

*Refer also to abstract 32283*

**32484 (ANL-6370) CORROSION STUDIES OF TERNARY ZIRCONIUM ALLOYS IN HIGH-TEMPERATURE WATER AND STEAM.** R. D. Misch and C. Van Drunen (Argonne National Lab., Ill.). July 1961. Contract W-31-109-eng-38. 37p.

The alloying of zirconium to improve corrosion resistance has an empirical basis, and satisfactory explanations for the alloying effects are not available. A theory of compensating valencies in the corrosion oxide is proposed, in which cations of lower and higher valence than zirconium (+4) are present in ratios such that electrostatic neutrality is ensured. An example is an alloy containing equimolar amounts of scandium (+3) and niobium (+5). A number of zirconium alloys were prepared in which scandium or yttrium were paired with elements capable of a +5 or +6 valence. The ternary alloys containing scandium were

superior to the alloys containing yttrium. The alloys containing scandium plus molybdenum, tantalum, or tungsten had relatively long lifetimes in steam at 540°C and 600 psi as compared with other alloy combinations, including Zircaloy-2. A quenched alloy containing 0.025 wt% Sc and 0.053 at.% Mo, that is, 0.05 mol.% of each additive, corroded approximately according to a cubic law up to 758 hr, at which point the rate suddenly increased in a manner suggesting hydrogen damage. Examination of the oxide film from alloys containing scandium and molybdenum showed only monoclinic ZrO<sub>2</sub>. It is believed that stabilization of this form of ZrO<sub>2</sub> instead of the cubic or tetragonal forms is a factor in promoting corrosion resistance. In this way the protective character of the film can be improved independently of the addition of cathodes. (auth)

**32485 (APEX-673) PROPERTIES OF LITHIUM HYDRIDE. V. CORROSION OF AUSTENITIC STAINLESS STEELS IN MOLTEN LiH.** Frank H. Welch (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). May 31, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 69p.

The mechanical properties (ultimate tensile strength, 0.2% yield strength, and percent elongation) of unwelded and welded types 301, 304, 316, and 321 and welded 316 ELC, 317, 318, and 347 stainless steels were determined after exposure to molten lithium hydride at 1325 ± 25°F for periods up to 100 hours. In general, the tensile and yield strengths were not markedly different from the control specimen values, although the percent elongation in all cases decreased. Metallographic examination showed negligible attack on all alloys after 100 hours exposure at 1325°F. Increasing the temperature to 1425°F produced attack (up to 0.004 inch) after 100 hours exposure. Type 321 stainless steel exhibited the largest amount of damage. Weight change measurements showed insignificant losses at all exposure conditions. (auth)

**32486 (KAPL-M-BED-3) THE CORROSION BEHAVIOR OF HAFNIUM IN AQUEOUS MEDIA AS A FUNCTION OF TEMPERATURE.** B. E. Dearing and A. M. Andrako (Knolls Atomic Power Lab., Schenectady, N. Y.). Aug. 4, 1961. Contract W-31-109-Eng-52. 11p.

A small integrated hafnium corrosion test was made using identical material in each of three environments: 540°F water, 680°F water, and 750°F steam. The tests were continued for 196 days in water and 98 days in steam. There was no linear correlation between steam and water corrosion. There was a different corrosion mechanism in steam as opposed to water. It was found that the presence of iron in hafnium is not required for good water corrosion resistance but the presence of iron can appreciably improve the 750°F steam corrosion resistance of hafnium. (auth)

**32487 (ORNL-3176(p.60-7)) ELECTROCHEMISTRY OF CORROSION.** G. H. Cartledge and D. H. Spahrbrier, et. al. (Oak Ridge National Lab., Tenn.).

Polarization measurements on the relative rates of reduction of oxygen and reducible inhibitors on the surface of passive iron provided important data on the mechanism of maintenance of passivity. The rate of reduction of the pertechnetate ion was much smaller than that of oxygen, but the reduction product [presumably Tc(OH)<sub>4</sub>] catalyzed the reduction reactions of both oxygen and the pertechnetate ion. The rate of reduction of the chromate ion was also smaller than that of oxygen, but its reduction product did not function as a catalyst. In contrast, the reduction of osmium(VIII) oxide was very much faster than that of oxygen, and very small amounts of the reduction product catalyzed cathodic processes in the system. Studies on

carbonyl iron powder passivated in chromate solutions showed that chromate ions are retained on the passive surface after water washing and may be displaced by hydroxide or sulfate ions. Extractions with  $\text{NH}_4\text{OH}$  and  $\text{NaOH}$ , followed by analysis with diphenylcarbazide, showed that unreduced chromate is removed and indicated that the surface is nonuniform with respect to the adsorption of chromate ion. Similar experiments with the pertechnetate ion gave no evidence of exchangeable technetium after water washing. Studies on the effects of  $\text{SCN}^-$ ,  $\text{OH}^-$ ,  $\text{SO}_4^{2-}$ , and  $\text{Cl}^-$  on the reduction of cupric ion on passive stainless steel showed that adsorption of these ions on the surface affects the reduction kinetics. The adsorption reactions followed a potential-dependent Langmuir isotherm to a good approximation. In simple cases, it was possible to calculate enthalpies and entropies of adsorption from the data. The rate of reduction of hydrogen ions on passive zirconium was determined as a function of film thickness, thus providing a basis for assessing the merits of several alternative theories of the distribution of potential and the nature of the rate-controlling steps in processes occurring at the oxide-solution interface. The kinetics of oxygen reduction was investigated as a function of electrode potential and pH, together with a determination of the amount of hydrogen peroxide produced as a reaction intermediate. A detailed study was made of transient and steady-state polarization characteristics of iron actively corroding in benzoate solutions. The great variety of Tafel slopes reported in the literature for the iron system is explained as a result of neglect of the effect of slow transients by previous investigators. The phenomenon of hysteresis in the polarization of iron is a straight-forward consequence of the existence of very slow processes in the iron system. (auth)

**32488** (TID-13099) CORROSION INVESTIGATION OF HASTELLOY X AND TUNGSTEN DURING DISSOLUTION OF  $\text{ZrO}_2$  WITH HF. F. W. Fink, P. D. Miller, and E. L. White (Battelle Memorial Inst., Columbus, Ohio). July 31, 1961. Contract W-7405-Eng-92. 16p.

Experiments were conducted to determine the corrosion resistance of boron carbide, Hastelloy X, tungsten, and a  $5\text{Cu}-5\text{Ni}-\text{W}$  alloy to molten  $\text{LiF}-\text{NaF}$  under an HF sparge at  $700^\circ\text{C}$ . A comparison was made of the results to previous results for INOR-8 under the same conditions. (B.O.G.)

**32489** (TID-13206) CORROSION INVESTIGATION OF INOR-8 UNDER FLUORINATION CONDITIONS. F. W. Fink (Battelle Memorial Inst., Columbus, Ohio). June 30, 1961. Contract W-7405-Eng-26. 17p.

A study was made on corrosion of INOR-8 specimens and welds subjected to a  $\text{F}_2$  sparge in  $\text{NaF}-\text{LiF}-\text{ZrF}_4$  at  $500^\circ\text{C}$  in the presence of  $\text{UF}_4$ . At the end of 148 hr exposure, the specimens were examined; no accelerated attack or intergranular attack was observed. The results are compared with other work. (D.L.C.)

**32490** (HW-TR-29) COOLING BY LIQUID METALS. PROBLEMS OF COMPATIBILITY. R. Darras. Translated for General Electric Co. Hanford Atomic Products Operation, Richland, Wash. from *Energie nucléaire*, 3: 128-38 (Mar.-Apr. 1961). 26p.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 15, abstract no. 19904.

**32491** (NP-tr-781) INVESTIGATION OF THE HEAT CORROSION RESISTANCE AND STRUCTURE OF A NUMBER OF IRON-BASE ALLOYS, RELATIVE TO THEIR COMPOSITIONS. S. D. Gertsriken, I. Ya. Dekhtyar, and L. M. Kumok. Translated from *Issledovaniya po Zharoproch. Splavam*, Akad. Nauk S.S.S.R., Inst. Met. im. A. A. Baikova, 6: 259-67 (1960). 12p.

A discussion is given of the investigations carried out in the search for heat-resisting iron alloys suited for long-term service at elevated temperatures as gas-turbine parts. The studies included heat resistance, corrosion resistance, weldability, and x-ray structural analysis. (B.O.G.)

**32492** EVALUATION OF TANTALUM, MOLYBDENUM AND BERYLLIUM FOR LIQUID BISMUTH SERVICE.

Joseph W. Seifert (Babcock & Wilcox Co., Alliance, Ohio) and Arthur L. Lowe, Jr. *Corrosion*, 17: 475t-8t (Oct. 1961).

Laboratory capsule tests were made to determine the suitability of tantalum, molybdenum, and beryllium for the containment of liquid bismuth in a liquid metal fuel reactor. All the materials tested had adequate corrosion resistance at 750 and 975 F. The corrosion resistance of tantalum appeared to be related to the surface finish, with welding having no effect on the material's corrosion resistance. Increasing velocity seemed to adversely affect the corrosion resistance of molybdenum +0.5 Ti but had no effect on tantalum. Beryllium did not appear to be affected by velocity in the range studied. (auth)

**32493** CORROSION RESISTANCE OF TITANIUM, ZIRCONIUM AND TANTALUM USED FOR CHEMICAL EQUIPMENT. Clifford A. Hampel. *Corrosion*, 17: No. 10, 9-10; 12; 14; 16-17 (Oct. 1961).

Properties of titanium, zirconium, and tantalum in corrosive environments of the chemical industry are detailed. Hydrogen absorption properties and resistance to numerous corrosives at varying temperatures are related and tabulated. Some special problems faced when these metals are fabricated are considered and solutions of some are described. (auth)

**32494** WATER TREATMENT FOR CORROSION CONTROL OF ALUMINIUM IN LOW TEMPERATURE NUCLEAR REACTORS. E. W. Jackson and H. F. Molineaux (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). *Corrosion Prevent. & Control*, 8: No. 8, 36-8; 54 (Aug. 1961).

An ion exchange process is described for purifying reactor cooling water which comes in contact with aluminum. The ion exchange treatment lowers the corrosion rate to a minimum and removes the fission products formed in the water during the operation of the reactor. The treatment removes the small ions of the halogens and the small concentrations of heavy metals which enhance corrosion. A typical reactor cooling water circuit is shown in a diagram. The treatment thus allows a film to be formed on the aluminum, usually Bayerite,  $\text{Al}(\text{OH})_3$ , at normal temperatures and Bohmite,  $\text{AlO}(\text{OH})$ , at  $70$  to  $100^\circ\text{C}$ . (N.W.R.)

**32495** MECHANISM OF CORROSION OF AN ALUMINUM-URANIUM ALLOY IN DEMINERALISED WATER AND IN BORIC ACID SOLUTION. H. Coriou, L. Grall, and G. Kurka (Centre d'Etudes nucleaires, Saclay, France). *Mém. sci. rev. mét.*, 58: 209-14 (Mar. 1961). (In French)

The alloy studied is a fuel used in canned form in swimming-pool type reactors or in critical assemblies for nuclear measurements. This study was undertaken to determine the behavior of ruptured can or the use of bare sections. The alloy contains 21.8% uranium and is prepared by vacuum melting; its structure shows pronounced precipitation of large  $\text{UAl}_4$  platelets in an aluminum matrix; it is heterogeneous to its hypereutectic composition. The corrosion characteristics depend strictly on this structure: general corrosive attack is very slight and deep pits, which may lead to perforation, develop on the large  $\text{UAl}_4$  inclusions. However, as this corrosion is very localized, dissolution of uranium is slight and its effect on the reactor represents no



immediate risk. On the other hand, in boric acid the corrosion is clearly less marked as the acid pH is favorable. An alloy of eutectic composition (approximately 13% U) would be more favorable since this eliminates the formation of large  $UAl_3$  platelets which are responsible for the observed pitting. (auth)

**32496** INHIBITION OF STRESS-CORROSION CRACKING OF AUSTENITIC STAINLESS STEEL. P. P. Snowden (Brown-Firth Research Labs., Sheffield, Eng.). Nuclear Eng., 6: 409-11 (Oct. 1961).

The effects of a number of inhibitors on the stress-corrosion behavior of an 18/9 Cr-Ni, Nb stabilized, austenitic stainless steel were investigated in tests closely simulating severe conditions likely to be met in practice. In chloride environments tri-sodium phosphate present in a ratio of not less than 1:2, tri-sodium phosphate: sodium chloride, was shown to prevent, or at least greatly delay, stress-corrosion cracking. Its use in conjunction with other currently accepted methods of protection would significantly reduce the risk of attack under actual operating conditions. (auth)

## Fabrication

**32497** (ASD-TR-7-784(V) THE DEVELOPMENT OF OPTIMUM MANUFACTURING METHODS FOR COLUMBIUM ALLOY SHEET. Interim Technical Engineering Report, March 15, 1961-July 31, 1961. J. B. Guernsey (Crucible Steel Co. of America, Midland Research Lab., Penna.), Sept. 1961. Contract AF33(600)-39942. 31p.

F48 niobium alloy sheet processed from various locations of an 8-in. diameter electron beam melt plus vacuum arc remelt ingot had good properties and excellent uniformity between ingot locations. Elevated temperature tensile strength and stress rupture properties were comparable to results previously reported for higher oxygen double vacuum arc melted material. Another 8-in. diameter F48 ingot was cast and forged to  $1\frac{3}{4}$ -in. thick slab, and a small portion of the slab was lab processed to sheet. Room temperature properties were comparable to those obtained in the within-ingot uniformity study above. Elevated temperature strength was significantly higher, probably due to a higher molybdenum content. Test procedures are described in some detail. Testing speed was found to be an important factor in bend testing. A laboratory rolling program is being conducted on the F48 alloy to determine optimum sheet processing techniques. It appears that temperatures of at least 2500F are required for sheet bar rolling. Two 8-in. diameter D31 ingots were cast by the electron beam melt plus vacuum arc remelt technique. These ingots will be evaluated to determine uniformity within an ingot and between ingots. A round robin was conducted on chemical analysis of D31. Agreement was good on carbon, molybdenum, and titanium, but oxygen, nitrogen, and hydrogen results varied to some degree. (auth)

**32498** (DMIC-159) GAS-PRESSURE BONDING. S. J. Paprocki, E. S. Hodge, and P. J. Gripshover (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Sept. 25, 1961. Contract AF33(616)-7747. 41p.

Gas-pressure bonding, employing gas at high pressure and elevated temperature, was successfully used for joining, cladding, and densifying many material systems including metals, ceramics, and cermets. Bonding parameters are summarized for the joining of many materials, including the refractory metals. By the use of these techniques, refractory-metal powders can be consolidated to

near theoretical density at no more than 2700°F. The process appears to have wide applicability in the fabrication of brittle materials and of materials with widely differing properties. (auth)

**32499** (GA-2502) A PROGRAM OF RESEARCH ON MECHANICAL METALLURGY AS RELATED TO FUEL-ELEMENT FABRICATION. Quarterly Progress Report for the Period Ending June 30, 1961. T. A. Trozera, K. Koyama, J. L. White, and R. H. Chambers (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Aug. 31, 1961. Contract AT(04-3)-167. 23p.

Results of drawing experiments using  $\frac{3}{8}$ -in. bars to provide rod and tube test specimens are reported. In mechanical metallurgy investigations on the relation of formability to imperfection structure the peierls potentials for dislocation of Nb, Mo, Ta, and W were measured. Design and construction of a microextensometer is reported. The investigations of the effects of grain size on the stored energy cold work were extended to a new lot of OFHC Cu. In studies of formability relations with imperfection structure, a detailed study is reported on the internal-friction relaxation spectrum of Ta relatively unmodified by impurities. A summary of interstitial impurity effects on the internal-friction of Ta is given. (J.R.D.)

**32500** (HW-63360) COMPLETION REPORT; AN AUTOMATIC FUEL ELEMENT STAMPING MACHINE. C. H. Allen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 12, 1960. Contract AT(45-1)-1350. 13p.

The design, operation, and maintenance of an automatic stamping machine for HAPO fuel elements are described. The machine, essentially a mechanization of manual impact stampers, stamps much neater and cleaner than the manual arrangements and can stamp 12 to 15 elements per minute. (D.L.C.)

**32501** (KAPL-M-MJG-2) DEVELOPMENT OF A PROCESS FOR FABRICATING BONDED-INCONEL-CLAD OFHC COPPER ROD. M. J. Galvez (Knolls Atomic Power Lab., Schenectady, N. Y.). July 1961. Contract W-31-109-eng-52.

Development of a process is described for fabricating bonded Inconel-clad OFHC copper rods required for production of electric induction coils. An outline of the process is included. (J.R.D.)

**32502** (NMI-1250) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY; EXTRUSION BY HYDROSTATIC PRESSURE. Final Report for the Period July 1, 1960 through June 30, 1961. R. N. Randall, D. M. Davies, J. M. Siergiej, and P. Loewenstein (Nuclear Metals, Inc., Concord, Mass.). July 13, 1961. Changed from OFFICIAL USE ONLY Aug. 2, 1961. Contract AT(30-1)-1565. 34p.

Experimental extrusions were made from a container in which the billets were surrounded by a fluid under hydrostatic pressure. Copper, aluminum, mild steel, yttrium, and beryllium billets were extruded at room temperature at various reductions. Attempts to extrude at 900°F from a container filled with liquid lead were unsuccessful because of the failure of the containers at pressures greater than 100,000 psi. The pressures required for extrusion of copper and aluminum were approximately the same as were required for extrusion by conventional means. (auth)

**32503** (NYO-2693) NUCLEAR FUEL RESEARCH FUEL CYCLE DEVELOPMENT PROGRAM QUARTERLY PROGRESS REPORT, APRIL 1-JUNE 30, 1961. (United Nuclear Corp. Fuels Div., New Haven). Aug. 10, 1961. Contract AT(30-1)-2374. 43p.

The fabrication and encapsulation of 4.95% enriched  $\text{UO}_2$  pellets, preparatory to irradiation testing, is described. The pellets are produced by sintering in  $\text{N}_2$  or  $\text{H}_2$  at 1000 to 1300°C, with initial grain sizes of 5 to 10  $\mu$ ; pellet densities of 95 to 98% of the theoretical density are produced. The O/U ratio of the pellets is determined, and their microstructure is investigated. The effects of processing variables on the final grain sizes and on the removal of fluoride impurities are examined. A method is described by which the C content in UC may be controlled to  $\pm 0.1$  wt%. The sintering characteristics of 4.0 to 4.7 wt% carbon in UC at 1200 to 1800°C are studied. The consolidation of UC by skull melting is also considered. (T.F.H.)

**32504** (ORO-473) FUEL-BEARING FIBERGLAS IN ALUMINUM BASE FUEL ELEMENTS. Monthly Progress Letter No. 24, August 1, 1961–August 31, 1961. R. H. Baskey (Clevite Corp. Mechanical Research Div., Cleveland). Sept. 14, 1961. Contract AT(40-1)-2557. 5p.

Progress is reported on hot-pressing and rolling techniques for fabricating Al-coated, U-bearing fiberglass cores for Al-clad fuel elements. (T.F.H.)

**32505** (SCNC-332) THE FABRICATION OF BERYLLIUM BY HOT ISOSTATIC PRESSING AND BY IMPACT EXTRUSION. I. Sheinhart (Sylvania Electric Products Inc. Sylcor Div., Bayside, N. Y.). Sept. 1961. For General Nuclear Engineering Corp., Dunedin, Fla. Contract AT(38-1)-200, Subcontract 40-9-11. 42p.

The feasibility of producing a finned beryllium tube by the hot isostatic pressing of beryllium powder was demonstrated. The powder was pressed directly into the final shape so that only a minimum of machining would be required. Hot pressed beryllium billets and porous cold compacted billets were extruded by the Dynapak. The mechanical properties of the extruded material depended on the extrusion temperature and the density of the compact. (auth)

**32506** (NP-tr-758) FLUX EQUIPMENT FOR AUTOMATIC AND SEMIAUTOMATIC WELDING. (Flyusovaya Apparatura Dlya Avtomaticheskoy Polyavtomaticheskoy Svarki). A. I. Chvertko. Translated from a publication of Mashgiz, Moscow, 1960. 210p.

The process of welding under flux is described and the design of flux equipment for automatic and semi-automatic welding is discussed. The parameters involved in the design of flux equipment is considered in detail, and some commercial flux equipment is described. Finally, the application of flux equipment in industry is considered. (D.L.C.)

**32507** LESS COMMON METALS. E. M. Sherwood (Battelle Memorial Inst., Columbus, Ohio). Ind. Eng. Chem., 53: 922-4(Nov. 1961).

A review is given on developments and improvements in process technology for fabricating beryllium, chromium, hafnium, molybdenum, niobium, rhenium, tantalum, tungsten, and zirconium. The references given cover the period June 1960 through May 1961. (N.W.R.)

**32508** PRESSURELESS COMPACTING AND SINTERING METAL POWDERS. H. H. Hausner. J. Metals, 13: 752-8(Oct. 1961).

The basic differences between masses of loose or pressureless compacted metal powders and those which are compacted under pressure are discussed. Methods for pressureless forming and compacting of metal powder particles are shown to result in agglomerates of high densities. The size distribution of the powder particles is of prime importance in the loose powder sintering, vibratory compacting, and slip casting processes described. It is

emphasized that methods of compacting without application of pressure are not supposed to replace the conventional powder metallurgy methods in which pressure is applied. (P.C.H.)

**32509** EVALUATION OF DRAWING LUBRICANTS FOR TANTALUM AND URANIUM. R. I. Batista (Los Alamos Scientific Lab., N. Mex.), Gale S. Hanks, James M. Taub, and D. J. Murphy. Lubrication Eng., 17: No. 9, 5p. (Sept. 1961).

A simplified testing device utilizing a draw bench and auxiliary components was developed for evaluating the friction reducing characteristics of possible lubricants for use with usual metals and alloys. Data were obtained for a variety of lubricants and die materials employed with tantalum and uranium. The device and procedure provide a means for extensive evaluation of other combinations of dies, lubricants, and metals. (auth)

**32510** RADIOACTIVE METHODS OF MEASURING KINETICS OF PHOSPHATE COATINGS. V. S. Lapatukhin and Yu. M. Ovchinnikov. Zhur. Priklad. Khim., 34: 1231-5 (June 1961). (In Russian)

A  $\text{P}^{32}$  tracer was used in investigating phosphate coating kinetics. The initial coating stages proceed at a maximum rate. The rate decreases in the intermediate stages, and under certain conditions, some coating dissolution occurs. The method was sufficient for determining coating rates, porosity, and uniformity. (R.V.J.)

**32511** MATERIALS FOR PROTECTION AGAINST IONIZING RADIATION. J. Slaba and L. V. Potuček. French Patent 1,187,569. Mar. 2, 1959.

Shielding elements are manufactured from metallurgical wastes which contain any combination of the elements Pb, Fe, Sn, Si, Ca, Sb, As, Mn, Mg, Al, W, Cr, Cu, Zn, Na, Ag, Ni, Cd, Li, and Ti either in elementary form or, preferably, in the form of oxides or sulfides (such as wastes from the metallurgy of Pb, non-roasted pyrites) and a suitable organic or inorganic binder (such as Portland cement). (NPO)

**32512** IMPROVED PROCESS FOR MAKING OPENINGS IN PRESSURE VESSELS AND IMPROVED IMPLEMENT FOR CARRYING OUT THIS PROCESS. (to Babcock & Wilcox Ltd.). French Patent 1,217,300. May 3, 1960.

During the erection of the pressure vessel of a reactor, it is often necessary to provide it with a multitude of openings with a vertical axis, in particular for the charging of the fuel elements or for the introduction of the control rods. The process for making these openings consists in first making access holes in the vessel wall smaller than the vertical holes required and lying within the areas which the latter holes will occupy. Outside the vessel near the place of an access hole a support is then placed for a rotating tool, which passes through the access hole. The axis of rotation of the tool is aligned by optical means with respect to a point on the side of the wall opposite to the tool support. Finally the tool is operated to remove an annular portion from the wall by oxyacetylene cutting. (NPO)

**32513** POROUS BODIES, SUCH AS CARBON OR GRAPHITE, WITH AN IMPERMEABLE SURFACE, ESPECIALLY FOR ARC ELECTRODES OR FOR THE CONSTRUCTION OF NUCLEAR REACTORS. (to Siemens Planawerke A. G. für Kohlefabrikate). French Patent 1,219,255. Dec. 28, 1959.

Porous bodies consisting of graphite or silicon carbide (such as fuel element cans) are made impermeable to fluids by coating them with a bottom layer which consists of a carbide of Zr, Si, and/or Ti and a top layer which consists of Zr, Si, and/or Ti or their silicides. Other



metals can be incorporated in the coatings. Examples of the method of applying coatings are given. (NPO)

**32514 IMPROVEMENTS RELATING TO THE MANUFACTURE OF ELEMENTS UNDERGOING NUCLEAR REACTIONS INDUCED BY NEUTRONS OR OF NEUTRON ABSORBING ELEMENTS FOR NUCLEAR REACTOR.** (to Babcock & Wilcox Co.). French Patent 1,227,586. Aug. 22, 1960.

For the manufacture of a reactor element of a given length and a given section, the nuclear fuel or the neutron absorbent in powder form is filled into a sheathing tube having a length shorter than the desired length and a section greater than the desired section. Vibrations or other mechanical means are used to pack the powders into the sheathing tube. The sheathing tube is then closed and mechanically shaped with a die until the required length and section are attained. The fuel or absorbent density obtained is much higher than the density of the powder in the free state. (NPO)

**32515 MANUFACTURING PROCESS FOR TILES, BLOCKS AND TABLETS HAVING A HIGH RESISTANCE TO HEAT AND RADIOACTIVE RADIATION.** French Patent 1,230,400. Sept. 15, 1960.

A manufacturing process is described for tiles, blocks, and tablets having a high resistance to heat and radiation. In this process, a mixture of calcium sulfate and asbestos fibers in the proportion of 2:3 to 3:2 is treated with: from 5 to 10% by weight of a metal sulfate, from 5 to 10% sodium silicate, from 3 to 6% hydrochloric acid and, optionally, from 3 to 6% calcium chloride, and sufficient non-alkaline water to render the mixture moist. This mass is then shaped by rolling or compressing and finally dried. (NPO)

**32516 METHOD OF COATING GRAPHITE WITH NIOBIUM CARBIDE.** (to U. S. Atomic Energy Commission). French Patent 1,234,942. May 23, 1960.

Graphite objects, such as moderator elements or fuel element sleeves, are coated with a thin layer of niobium powder (particle size 0.074 mm) and degasified at 1400°C and  $10^{-3}$  mm Hg. At this pressure the temperature is then rapidly, within 15 min, raised to 2500°C. The molten metal wets the graphite and is converted after 20 min at 2500°C into the carbide. The coated objects have a high corrosion resistance. (NPO)

**32517 METHOD FOR MANUFACTURING MOLDED OBJECTS CONSISTING OF URANIUM SILICIDES.** (to Commissariat à l'Energie Atomique). French Patent 1,235,561. May 30, 1960.

A method and apparatus are described for manufacturing molded objects (rods or hollow cylinders) consisting of  $U_3Si_2$ ,  $USi$ ,  $USi_2$ , or  $USi_3$ . A graphite mold is filled under vibration with a homogeneous mixture of uranium and silicon that has the desired composition and heated in a vacuum at 450 to 650°C to convert the mixture into uranium silicide. The object is then removed from the mold and sintered by induction heating at 1500°C in a vacuum. (NPO)

**32518 METHOD OF MANUFACTURING FUEL ELEMENT SLUGS AND FUEL ELEMENTS OBTAINED BY THIS METHOD.** (to Compagnie pour l'Etude et la Réalisation de Combustibles Atomiques). French Patent 1,240,576. Aug. 1, 1960.

The slugs are provided with surface grooves, such as a countersunk screw-thread, into which the can is pressed. In order to avoid mechanical deformation and rupture of the can during service the grooves are not made by machining, but by surface deformation of the slugs. (NPO)

**32519 SLUG CANNING.** (to Allmänna Svenska Elektriska Aktiebolaget). French Patent 1,244,632. Sept. 19, 1960.

The can of a fuel element that is to be applied in a heterogeneous reactor with a pressurized coolant consists of a tube of some tough material, such as stainless steel, which snugly envelops the fuel slugs and has such a wall thickness that a certain plastic deformation caused by the coolant pressure is possible. Thus a close contact between can and slugs is preserved. The fuel elements are manufactured by introducing a number of slightly convex, concave, or tapered slugs, provided with a central channel, into the tube, capping the tube and heating the tube while subjecting it to a high gas pressure. (NPO)

**32520 FUEL ELEMENTS FOR NUCLEAR REACTORS.** (to United Kingdom Atomic Energy Authority). French Patent 1,244,856. Sept. 19, 1960.

Fuel elements which consist of an assembly of parallel sheathed fuel plates in a rectangular box are described. Each relatively thin sheath is provided on one or both sides with a number of relatively strong, straight or curved, longitudinal ribs which serve as spacers and allow a certain deformation of the sheaths. The sheaths are manufactured from two sheets, the reinforced edges of which are bent inwardly and welded together. To enable some dilation of the fuel plates a clearance is left between the edges of the plates and the welded edges of the sheath. (NPO)

**32521 IMPROVEMENTS IN BRAZING.** (to United Kingdom Atomic Energy Authority). French Patent 1,246,061. Oct. 3, 1960.

The manufacture of a fuel element consisting of two coaxial tubes between which curved, sheathed fuel plates are fixed, the cross-section thus resembling a wheel with curved spokes is described. The fuel plates are made by lamination, rolling, and bending. Solder strips are fixed on the extremities of the plates prior to rolling, the latter are then mounted in slits in the tubes and the parts are finally dip-brazed. (NPO)

**32522 IMPROVED CAN FOR NUCLEAR FUEL ELEMENT AND METHOD OF MANUFACTURE.** (to Electricité de France (Service National)). French Patent 1,246,897. Oct. 17, 1960.

Fuel element cans with helical or longitudinal fins are described. In order to improve heat transfer the fins are cut through at the lines of intersection with imaginary helical planes and each fin portion thus formed is severed from the can at one end and bent; all fin portions are bent at the same end and in the same sense. (NPO)

**32523 ASSEMBLING ELEMENTS, PARTICULARLY NUCLEAR FUEL ELEMENTS.** (to Sylvania Corning Nuclear Corp.). French Patent 1,250,220. Nov. 28, 1960.

The manufacture of fuel elements which consist of a number of parallel sheathed fuel plates that are held together by two transverse side plates is described. The fuel plates are placed in grooves in the side plates (clearance about 0.18 mm) after which the plates are bonded together by exerting a pressure of about 6 tons/cm on the edges of the side plates. The bond can be reinforced by putting some  $SiC$ ,  $Al_2O_3$ , or  $BeO$  powder in the grooves. (NPO)

**32524 METHOD OF MANUFACTURING FUEL ELEMENTS FOR NUCLEAR REACTORS.** (to U. S. Atomic Energy Commission). French Patent 1,252,430. Dec. 19, 1960.

A composite, consisting of a U-2% Zr core and a Zircaloy-2 sleeve, is extruded until the desired dimen-

sions are obtained and then so heated as to form a Zr—U diffusion layer between core and sleeve, such as 24 hr at 850°C, 2 hr at 1050°C, or 1 hr at 1100°C. The diffusion layer protects the core against hot water corrosion in case of can failure. (NPO)

**32525** METHOD OF MANUFACTURING A NUCLEAR FUEL. (to United Kingdom Atomic Energy Authority). French Patent 1,252,507. Dec. 19, 1960.

Uranium powder is converted into uranium carbide by heating in propane in a rotating furnace at 700°C. The temperature is then raised to 775 to 900°C, so that the particles become coated with a layer of pyrolytic carbon. The coated particles are cold compacted with ultra-fine graphite powder. (NPO)

**32526** IMPROVEMENTS IN FUEL ELEMENTS FOR A NUCLEAR REACTOR. (to Electricité de France (Service National)). French Patent 1,256,686. Feb. 13, 1961.

A compression resistant fuel rod consisting of a hollow uranium cylinder filled with a core of pressure resistant fissile material, such as sintered uranium oxide or carbide pellets, is described. Conical end plugs are pressed against the core, so that the load of a vertical pile of rods is carried by the core. (NPO)

## Properties and Structure

*Refer also to abstract 32656*

**32527** (57GL88) INVESTIGATION OF POSSIBLE BEARING MATERIALS AND LUBRICANTS ABOVE 1000°F. M. B. Peterson and S. F. Murray (General Electric Co. General Engineering Lab., Schenectady, N. Y.). Mar. 13, 1957. 131p.

Screening tests are performed on bearing materials and lubricants in sliding contact at 1000 and 1600°F and in rolling contact at 700 and 1000°F. The materials having high performance in the screening tests are given journal-bearing and rolling-ball tests, and the lubricants are given Shell 4-Ball and rotating cup sliding tests, in the vicinity of 1000°F. The tests determine the friction coefficients and wear rates for (metal or alloy) vs. (metal or alloy), (metal or alloy) vs. ceramic, and ceramic vs. ceramic pairs, using solid films and some molten salts and metals as lubricants. (T.F.H.)

**32528** (AD-245976L) HIGH TEMPERATURE DIELECTRIC MATERIALS. Final Report, April 1, 1959 to June 30, 1960. A. V. Ilyn and E. C. Henry (General Electric Co. Electronics Lab., Syracuse, N. Y.). Contract NObs-77070. 64p.

Activities in the first phase of a project to develop high temperature capacitors are reported. The goal of the program was to produce a material which exhibits a dielectric constant of at least 15 and preferably greater than 50, electrical resistivity greater than  $10^{11}$  ohm-cm, electrical Q of 1000 or greater and an RC product of 5 MΩ-μf at a minimum operating temperature of 275°C. The two compositions, equivalent to  $3\text{SrO} \cdot 2\text{Ta}_2\text{O}_5 \cdot \text{ZrO}_2$  and  $3\text{SrO} \cdot 2\text{Ta}_2\text{O}_5 \cdot \text{SnO}_2$ , were prepared and tested extensively. With the exception of electrical Q values, preliminary electrical measurements on samples of these compositions showed that they meet the specification goals at 350°C. Ten-mil thick samples of  $3\text{SrO} \cdot 2\text{Ta}_2\text{O}_5 \cdot \text{ZrO}_2$  were subjected to 600 volts at 275°C for 1000 hours. At the completion of this test the samples still possessed their initial good properties, i.e., a dielectric constant greater than 80, an electrical resistivity of  $10^{12}$  ohm-cm, and an RC product greater than 20. The values of elec-

trical Q, however, were only 200. In subsequent tests of at least 60 hours each at 300, 325, and 350°C, these same samples exhibited dielectric constant values greater than 80, maintained resistivity values above  $10^{11}$  ohm-cm and RC products greater than 5 megohm-microfarads. However, improvement of the electrical Q and the reproducibility of samples of these materials is required. (auth)

**32529** (AD-255079) THE ELECTRICAL BEHAVIOR OF REFRACTORY OXIDES. Bi-Monthly Progress Report. Robert W. Vest (Systems Research Labs., Inc., Dayton, Ohio). Mar. 21, 1961. Contract AF33(616)-7748. 15p.

The designs are given for a hot press, vacuum furnace, which will operate in vacuum or an inert atmosphere at temperatures to 2000°C and pressures to 4000 psi. A study of the preparation of dense zirconia by hydrostatic pressing sintering is currently being made. A high degree of sintering was obtained, but laminations were present to some extent in all samples. Plans for future work on zirconia crystals are also given. (P.C.H.)

**32530** (AD-255085) THERMODYNAMIC INVESTIGATION OF CERAMIC MATERIALS AT ELEVATED TEMPERATURES. Quarterly Report, December 15, 1960–March 15, 1961. Michael Hoch (Cincinnati. Univ. Research Foundation). Apr. 21, 1961. Contract AF33(616)-6299. 7p.

Measurements were begun on the change of partial free energy of oxygen in TiO. At 1375°K an emf which decreased with time from 100 to 5 mv in 4 hr was observed. The stabilization of cubic ZrO<sub>2</sub> using TiO<sub>2</sub>, Nb<sub>2</sub>O<sub>5</sub>, or Ta<sub>2</sub>O<sub>5</sub> plus another metal was studied. Transition metals used with TiO<sub>2</sub> stabilized cubic ZrO<sub>2</sub>. Phase studies were carried out on the Cr–Zr–O system. High purity boron phosphide was degassed at 1200°K until it reached constant weight. It was then decomposed at 1450° to constant weight. The residue weighed less than that calculated for an end product of B<sub>2</sub>P. (M.C.G.)

**32531** (AD-259043) THERMODYNAMIC PROPERTIES IN THE SYSTEM HYDROGEN-HAFNIUM. Russell K. Edwards and Ewald Veleckis (Illinois Inst. of Tech., Chicago. Armour Research Foundation). [1957]. 16p.

Presented at the April, 1957, Meeting of the American Chemical Society.

Equilibrium vapor pressure measurements were carried out as a function of composition for the H–Hf system in the temperature range 251 to 827°C and up to a maximum pressure of 1 atm. A partial phase diagram is presented. The extrapolated phase boundaries show good correlation with the room-temperature x-ray studies of Sidhu and McGuire. The solubility of H<sub>2</sub> in the primary solid solution phase, α Hf, reaches nearly 11 at.% H<sub>2</sub> at the highest temperature investigated but decreases rapidly at lower temperatures. Henry's law is obeyed by monoatomic H in the α phase. The δ phase exists from 24 at.% H<sub>2</sub> at the highest temperature and 63 at.% H<sub>2</sub> at the lowest temperature to ~64.3 at.% H<sub>2</sub>. The latter composition boundary remains essentially constant with temperature up to 365°C. A very narrow two-phase region separating the δ phase field and the ε phase field is inferred with the latter extending to HfH<sub>1.98</sub> for the lowest temperature. The relative partial molal and integral thermodynamic quantities in the composition range 0 to 56 at.% H<sub>2</sub> are presented for 779°C. The exothermic nature of the solution reaction was established. The integral enthalpy of solution at 50 at.% H<sub>2</sub> (δ phase) is –32.06 kcal/mole H<sub>2</sub>. The relative partial molal contribution of H<sub>2</sub> at this composition is –40.38 kcal/mole. (auth)

**32532** (AI-6358) THERMAL PROPERTIES OF REFRACTORY MATERIALS. Quarterly Progress Report No.



3, February 1, 1961 to April 31, 1961. J. A. Cape and R. E. Taylor (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 1961. Contract AF33(616)-6794. 27p. (AD-255894)

The construction of an automatic recording optical pyrometer was completed. This completed the apparatus for measurement of transient thermal properties. Preliminary results of the testing and alignment of the complete apparatus indicated that modifications must be made on the heater radiation shields to prevent spurious light from being collected by the pyrometer. The thermal conductivity of titanium carbide was measured over the temperature region from 400 to 1200°C. The steady state radial heat flow method was used. The conductivity varied linearly from 0.088 cal/sec cm°C at 500°C to 0.109 cal/sec cm°C at 1100°C. These results were in marked contrast to values reported in the literature. The techniques and apparatus for measuring the specific heat of brittle conductors by pulse heating are described. Resistivity and specific heat data for uranium silicide of several compositions are reported. The resistivity and specific heat increased with increasing silicon content. For uranium silicide containing 3.8% silicon, the resistivity increased from 56 microhm-cm at 0°C to 75 microhm-cm at 750°C and for uranium silicide containing 5.9% silicon, the resistivity increased from 81 microhm-cm at 0°C to 111 microhm-cm at 800°C. The specific heat for the 3.8% material is given by  $c_p = 3.16 \times 10^{-6} T + .0412 \text{ cal/gm } ^\circ\text{C}$  from 50 to 430°C and for the 5.8% material  $c_p = 16.1 \times 10^{-8} T + 0.0455 \text{ cal/gm } ^\circ\text{C}$  from 50° to 715°C. T is in °C. (auth)

**32533** (APEX-624) INVESTIGATION OF POSSIBLE BEARING MATERIALS AND LUBRICANTS FOR TEMPERATURES ABOVE 1000°F. M. B. Peterson and S. F. Murray (General Electric Co. General Engineering Lab., Schenectady, N. Y.). Apr. 15, 1959. For General Electric Co. Flight Propulsion Lab. Dept., Cincinnati. Contracts AF33(600)-38062 and AT(11-1)-171. 78p.

An exploratory investigation of bearing materials and lubricants was conducted to determine the feasibility of using various materials and lubricants for sliding and rolling contacts at temperatures above 1000°F and to obtain a better understanding of sliding processes at such temperatures. Screening tests were run on materials and lubricants in sliding contact at 1000° and 1600°F and in rolling contact at 700° and 1000°F. Journal bearing tests were also run at temperatures up to 1600°F with those materials and lubricants that seemed promising from the screening tests. Rolling ball tests were conducted at 700° and 1000°F on materials that seemed feasible as ball bearing materials; some lubricant tests were also run with the same device. Finally, data were obtained on various lubricants at 500° to 700°F on the Shell 4-Ball Tester. (auth)

**32534** (APEX-625) FRICTION AND WEAR OF REFRACTORY COMPOUNDS. K. P. Zeman, W. R. Young, and L. F. Coffin, Jr. (General Electric Co. Research Lab., Schenectady, N. Y.). May 1959. For General Electric Co. Flight Propulsion Lab. Dept., Cincinnati. Contracts AF33(600)-38062 and AT(11-1)-171. 83p.

A search was made for bearing materials that will perform satisfactorily in aircraft nuclear power plants with low friction and wear in an air atmosphere of 2000°F or higher. Refractory compounds for use as bearings were investigated as well as the possibility of employing various materials, both metallic and nonmetallic, as lubricants for these compounds. (auth)

**32535** (APEX-750) PROGRAM TO DEVELOP A WROUGHT BLADE SUPERALLOY. Wilford H. Coutts, Jr.

(General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Sept. 1, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 34p.

The current status of a wrought superalloy development program involving modifications of an Astroloy base is described. The goal was an alloy with 100-hour average life at 1900°F and 15,000 psi. The goal was not met by the variations employed to date, although various chemistries reported appear stronger than the best nickel-base superalloy currently in production. (auth)

**32536** (DMIC-Memo-130) REVIEW OF RECENT DEVELOPMENTS IN THE TECHNOLOGY OF COLUMBIUM AND TANTALUM. E. S. Bartlett and F. F. Schmidt (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Oct. 10, 1961. 8p.

Developments in the technology of niobium and tantalum and their alloys, as reported to the Defense Metals Information Center during the period from July through September, 1961, are reviewed. (M.C.G.)

**32537** (HW-59147) DISTRIBUTION OF THE ACTINIDE ELEMENTS IN THE MOLTEN SYSTEM:  $\text{KCl-AlCl}_3\text{-Al}$ . R. H. Moore and W. L. Lyon (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 20, 1959. Contract AT(45-1)-1350. 36p.

Data are reported for the distributions of elements 90 through 96 between molten salt solutions of their chlorides and molten aluminum (or alloy) at 725°C. The molten salt solutions were mixtures of aluminum trichloride and potassium chloride containing the actinide metal chloride. In all cases, the distributions were found to be strongly dependent upon the stoichiometry of the system and exhibited a maximum when the mole ratio of aluminum chloride to potassium chloride was approximately 1.0. This behavior was interpreted from the standpoint of the Lewis acid-base theory. The distributions for thorium, plutonium, americium, and curium were of the same order of magnitude, ranging from about 0.02 to 0.5. Those for neptunium were approximately a factor of ten larger than this, while those for uranium and protactinium were, respectively, a factor of 100 and 200 to 300 larger. These distributions led to separation factors of the order of 100 for uranium from plutonium or thorium, and up to 800 for thorium from protactinium. The pyrochemical processing implications of these data are briefly outlined. (auth)

**32538** (IS-118) A CALCULATION OF THE ELASTIC CONSTANTS OF YTTRIUM AND THE RARE-EARTH METALS. Benjamin T. Bernstein and John F. Smith (Ames Lab., Ames, Iowa). Nov. 1959. Contract W-7405-eng-82. 111p.

A modified cellular method developed by Raimes was extended to scandium, yttrium, and the rare earth metals. The assumption that the valence electrons are free and share the same ground state wave functions at zero wave number, was capable of giving fairly good agreement between the calculated and experimental values of the atomic radii, compressibilities, and total energies of the trivalent rare-earth metals as well as for scandium and yttrium. In addition the calculated variation of atomic radius and compressibility of the hexagonal rare-earth metals with atomic number was in qualitative agreement with experiment. Calculations based on the assumption that europium and ytterbium are divalent in the solid state were capable of giving reasonable agreement with the observed atomic radii and compressibilities of these elements. Calculations for cerium did not give satisfactory agreement with the assumption of either a trivalent or quadrivalent atomic core. This failure probably resulted from the fact that the

assumption of equivalent behavior of the valence electrons at zero wave number is quite poor for this element. The compressibilities of promethium and scandium were predicted. A calculation of the elastic shear constants of hexagonal close-packed yttrium at 0°K was made based on the assumption of nearly-free electron behavior for the valence electrons. The method developed by Reitz and Smith for hexagonal close-packed metals was applied. In order to obtain reasonable agreement with the experimental values it was assumed that electron overlap had occurred across the  $\{1\bar{1}0, 1\}$  and  $\{000, 2\}$  faces of the Brillouin zone and that there are an appreciable number of holes in the zone. The results are in agreement with the measured resistivity of single crystals of yttrium. (auth)

**32539** (IS-333) ZERO FIELD MAGNETIC PROPERTIES OF GADOLINIUM, TERBIUM, AND SAMARIUM. Emma Daniels Hill and F. H. Spedding (Ames Lab., Ames, Iowa). Nov. 1960. Contract W-7405-eng-82. 53p.

The mutual inductance or apparent susceptibility due to the presence of the sample in a coaxial inductance coil was observed for Gd, Tb, and Sm in fields of a few gauss over the respective temperature ranges of 78 to 310°K, 78 to 235°K, and 4.2 to 150°K. A paramagnetic Curie point of 284.2°K was found for Gd. For Tb, a transition was found which occurred to within 1° of the predicted temperature of 220°K, and a second peak occurred at 229.4°K which is within 2° of the heat capacity peak. The 220°K peak exhibited hysteresis and time dependence. Extrapolation of Tb data to  $\Delta M = 0$  yielded a Curie point of 235.6°K. No hysteresis was observed in the 14.8°K peak for Sm. (D.L.C.)

**32540** (KAPL-M-LSD-2) A COMPILATION OF DIFFUSION DATA FROM UNCLASSIFIED SOURCES FOR ZIRCONIUM, URANIUM AND NIOBIUM SYSTEMS. L. S. DeLuca (Knolls Atomic Power Lab., Schenectady, N. Y.). July 7, 1961. Contract W-31-109-eng-52. 18p.

Diffusion data for Nb, Zr, and U systems are reviewed. The general definition of the diffusion coefficient, specific definitions of various diffusion coefficients, variation of diffusion coefficient with temperature, reliability of measured diffusion constants, and layer growth rates are discussed. Self-diffusion coefficients are given for Zr, Nb, Sn, and U. Coefficients for the diffusion of gases in Zr and Nb and for self-diffusion in Zr alloys and Nb alloys are presented. Growth constants for intermediate layer formation in uranium alloys are given. (M.C.G.)

**32541** (NAMC-AML-1234) SUMMARY REPORT ON COATINGS FOR MOLYBDENUM (APRIL 1958 TO SEPTEMBER 1960). Robert G. Mahorter, Jr. (Naval Air Material Center, Aeronautical Materials Lab., Philadelphia). May 1, 1961. 22p. (AD-58935)

The relative thermal shock resistance in air, under stress, of 8 protective coatings was evaluated. The temperature cycle used was 1,800 to 200°F and the stress was 45,000 psi. The specimens were tested until failure or 500 cycles occurred. Specimens which performed well during the 1,800 to 200°F cycle were tested using a 2,000 to 300°F cycle. (auth)

**32542** (NASA-TN-D-838) INVESTIGATION OF OXIDATION-RESISTANT COATINGS ON GRAPHITES AND MOLYBDENUM IN TWO ARC-POWERED FACILITIES. Roger W. Peters and Thomas A. Rasnick (National Aeronautics and Space Administration, Langley Research Center, Langley Field, Va.). July 1961. 29p.

A number of leading-edge specimens were tested in a 6-inch subsonic low-pressure arc-powered tunnel and a

1,500-kw subsonic arc jet to determine the effectiveness of a siliconized coating for ATJ graphite and W-2 and Curak MG coatings for 0.5%-titanium-molybdenum alloy in preventing the oxidation of these materials. These coatings provided adequate protection at temperatures up to 3,000°F for the durations of the tests in these facilities, approximately 70 seconds in the arc tunnel and approximately 10 minutes in the arc jet. Minute weight losses of a few coated specimens indicate that tests of longer duration may impair the stability of these coatings. (auth)

**32543** (NASA-TN-D-906) INVESTIGATIONS OF THE DETERIORATION OF 22 REFRACTORY MATERIALS IN A MACH NUMBER 2 JET AT A STAGNATION TEMPERATURE OF 3,800°F. B. W. Lewis (National Aeronautics and Space Administration, Langley Research Center, Langley Field, Va.). June 1961. 17p.

A limited investigation of the deterioration characteristics of 22 refractory materials was conducted by exposing them to a stagnation temperature of 3800°F in a Mach number 2 ceramic-heated jet. The materials tested were six materials whose major constituent was silicon carbide, five cermets whose major constituent was titanium carbide, six materials whose major constituents were metal borides, four cermets containing alumina, and one silicon nitride model. Tests consisted of obtaining weight change and appearance changes for  $\frac{1}{2}$ -in.-diameter hemispherical-nose cylindrical models exposed to the air jet for 30 seconds at a time for a total of four runs or 2 minutes exposure. Curves of weight changes plotted against the number of 30-second tests in the jet were obtained. Estimates of average surface temperature near the stagnation point of the model were obtained by use of a special temperature-measuring camera. The models were examined before and after the completion of the tests for possible changes in microstructure; no significant changes were found. The data obtained were analyzed with the view that the oxidation characteristics of the materials were the main factor in deterioration of the materials under the conditions of the tests. It was concluded that only those materials which changed in weight the least could be recommended for further extensive application-oriented evaluations. The following materials fell in this category: silicon carbide-silicon, chromium-28% alumina cermet, titanium boride-5% boron carbide. The remainder of the materials tested had oxidation characteristics which appeared to be too severely limiting of their general applications to flight vehicles. (auth)

**32544** (NP-10827) SUBJECT INDEX, BIBLIOGRAPHY, AND CODE DESCRIPTION OF TECHNICAL CONFERENCE PAPERS ON PLASTICS: MARCH 1960-FEBRUARY 1961. Arnold E. Molzon (Picatinny Arsenal, Plastics Technical Evaluation Center, Dover, N. J.). July 1961. 65p. (Plas-tec Report-8)

Papers presented at the technical conferences on plastic materials and related technology, within a 1-year period ending on 15 February 1961, have been listed and indexed by subject. Over 450 papers from 14 conferences are covered. Included are a bibliography and identification of the company affiliations of the authors. (auth)

**32545** (NP-10859) PREPARATION AND EVALUATION OF HIGH PURITY BERYLLIUM. Bi-Monthly Progress Report, July 2 to September 1, 1961. G. E. Spangler, E. J. Arndt, and M. Herman (Franklin Inst. Labs. for Research and Development, Philadelphia). Contract NOW 61-0221-d. 12p. (P-A2476-5)

The zone refining of one inch diameter Pechiney beryllium (extruded powder rod) was attempted and discontinued



after three zone passes owing to the inability of the molten zones to concentrate the dross to the "finish" end. Other "starting" beryllium was zone refined as follows: four passes on one inch diameter Brush vacuum cast bar; five passes on one quarter inch diameter vacuum distilled bar produced at Nuclear Metals Corp; and two passes on one quarter inch diameter Pechiney grade SR extruded bar. Two specimens prepared from zone purified beryllium whose CRSS in tension was between 500 and 600 psi were tested in compression, the first oriented for basal slip and the second oriented for prism slip. CRSS for the former was 1100 psi and for the latter was 6500 psi. No change in the 5:1 ratio of stress for prism slip to basal slip was observed for this material. A specimen prepared from vacuum distilled beryllium (produced at NMC) with one zone pass was tested in tension. The CRSS for basal glide was 900 psi and the crystal failed at 32% elongation by basal plane cleavage. Several single crystals of zone refined beryllium were hot rolled and subsequently recrystallized. Highly oriented structures were obtained. Crude bend tests were performed on the polycrystalline material. One sample underwent a 60° bend producing a 10% strain in the outer fibers. (auth)

**32546** (NP-10863) PROGRESS REPORT NO. 13 ON [ELASTIC PROPERTIES OF CARBONS AND GRAPHITES], JULY 1, 1961 TO SEPTEMBER 30, 1961. J. F. Andrew, J. Distant, N. Juul, and T. Tsuzuku (Buffalo. Univ.). Oct. 15, 1961. Contract AF33(616)-7791. 20p.

A description of the preparations for carrying out experiments on internal friction in carbons in the range of low temperatures is presented, including a block diagram of the electronics in construction. Also, details are given from the work on thermal diffusivity at high temperature, carried out using the transient heat flow method and the steady sinusoidal heat flow method. Measurements of the elastic modulus as a function of temperature for four types of graphite (3000°C HT) were repeated and found to be the same as previously reported. Data on thermal diffusivity vs. temperature for various graphites in the direction perpendicular to the extrusion axis, and the ratio of the thermal conductivity to density and specific heat vs. temperature for various graphites are presented in graphical form. (P.C.H.)

**32547** (NYO-9640) THE COMPRESSIBILITY AND INTERNAL FRICTION OF CERTAIN BINARY LIQUID ALLOYS. Final Report. Gerald Abowitz and Robert B. Gordon (Yale Univ., New Haven. Hammond Metallurgical Lab.). Aug. 1961. Contract AT(30-1)-2029. 307p.

The velocity of sound, mass density, and thermal expansion coefficient were measured in dilute bismuth, lead, tin, zinc, cadmium, indium, and potassium amalgams as a function of composition. Measurements in the mercury-thallium system extended over the range 0 to 40 atomic % thallium. The sonic velocity determinations are also made as a function of temperature. The computed adiabatic compressibility,  $\beta_{ad}$ , is found to decrease more rapidly than is expected on the basis of a linear variation with composition. Two possible hypotheses are suggested to explain the experimental results. One is a change in the Debye characteristic temperature,  $\Theta_d$ , of mercury on alloying; the other is a change in the bonding of mercury itself which is assumed to have some covalent bonding. The velocity of sound was measured in several sodium-potassium alloys as a function of temperature. It is found to change in a nearly linear manner with composition. The behavior of  $\beta_{ad}$ , because of the volume contraction on alloying, cannot be explained in terms of a free electron model of the compressibility. It is hypothesized that changes in the elec-

tronic charge density occur upon solution giving rise to a volume contraction and the slight positive deviation in  $\beta_{ad}$ . Attenuation of sound measurements were carried out in mercury, sodium, and mercury-thallium alloys. Attenuation measurements as a function of frequency, 15 to 115 mc/s, and temperature, -13 to 72°C, indicate that the entire loss in mercury is caused by the sum of the shear viscosity and thermal conductivity losses. Within experimental error,  $\alpha/\nu^2$  is constant and of the magnitude predicted by the classical theories. The temperature dependence of  $\alpha$  is also found to obey the classical prediction. The measured attenuation in liquid sodium is approximately 25% greater than the calculated classical value. The frequency and temperature dependence apparently follow the predicted classical behavior; it is only in the absolute magnitude of the attenuation that there is disagreement. The reasons for the discrepancy are not known at the present time. An excess attenuation in liquid mercury-thallium alloys is observed. Measurements as a function of frequency and temperature in the more concentrated alloys are indicative of the presence of a relaxation effect. An analysis of this apparent relaxation phenomenon yields, for a 40 atomic % thallium alloy, an activation energy for the process of  $3600 \pm 300$  calories per mol and a  $\tau$  of about  $10^{-12}$  seconds. The relaxation mechanism appears to be diffusion limited. It is hypothesized that the mechanism responsible for the relaxation is that of a localized rearrangement of atoms in the liquid induced by the dilatational component of the longitudinal sound wave. (auth)

**32548** (PWAC-354) FUNDAMENTAL STUDY OF CREEP-RUPTURE UNDER COMBINED STRESS. G. H. Rowe and J. R. Stewart (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). June 30, 1961. Contract AT(11-1)-229. 41p.

An investigation of the fundamental concepts of combined stress creep-rupture was performed. Uniaxial and biaxial creep-rupture tests were conducted on a single heat of AMS-5648, type-316 stainless steel, at 1350, 1500, and 1650°F. Creep-rupture data obtained on uniaxial tensile specimens and capped end, thin wall tube specimens substantiate the Soderberg criterion for creep rate, and show that the creep strengths correlate on an effective stress-minimum effective creep rate basis rather than on a maximum stress basis. Rupture strengths of the tubes are best compared on an effective stress with the time to the beginning of uniaxial tertiary creep. The effective strain at beginning of tertiary creep for the uniaxial tests correlates better with the effective strain at rupture for the biaxial tests than does the effective rupture strain in the necked down section of the uniaxial tests. Good agreement is observed for rupture time on the maximum stress basis. Within the limits of material scatter and at the temperatures tested, this heat of material exhibited isotropic creep-rupture properties. (auth)

**32549** (TID-13678) PROPERTIES OF MATERIALS AT HIGH TEMPERATURES. Technical Progress Report, October 16, 1960–October 15, 1961. John L. Margrave (Wisconsin. Univ., Madison). Contract AT(11-1)-835. 42p.

Progress is reported on Langmuir rate-of-evaporation studies of Ir, Ru, and B; and studies of the surface tension and density of molten  $\text{Al}_2\text{O}_3$ . The thermodynamic properties of gaseous Tc, Ru, Te, I, Hf, Ti, Pb, Bi, Po, Rn, Ra, Ac, and Th are given at high temperatures, for the (+1) ions of these atoms. (T.F.H.)

**32550** (WADD-TR-61-44) THE EFFECTS OF STRAIN RATE AND HYDROGEN CONTENT ON THE LOW TEM-

PERATURE DEFORMATION BEHAVIOR OF COLUMBIUM. Period covered: December 1959 through December 1960.

B. A. Wilcox, A. W. Brisbane, and R. F. Klinger (Aeronautical Systems Div. Materials Central, Wright-Patterson AFB, Ohio). Mar. 1961. 30p.

The strain rate and temperature dependencies of the low temperature deformation behavior of fine grained arc-melted niobium, 1 ppm hydrogen were evaluated for tensile strain rates of 0.005, 0.10 and 6.0 in./in./min. The effect of 1, 9, and 30 ppm H on the mechanical behavior was investigated at 25 to  $-195^{\circ}\text{C}$ , using a tensile strain rate of 0.005/min. The existence of a hydrogen-dislocation interaction was confirmed by: calculation of an apparent activation energy for the early stages of low temperature deformation; observation of a hydrogen induced strain aging peak at  $-50^{\circ}\text{C}$ , for 30 ppm H; and observation of a serrated stress-strain curve at  $25^{\circ}\text{C}$  in coarse grained niobium containing 89 ppm H. (auth)

**32551** (WAL-371.9/2) INVESTIGATION OF TITANIUM BORONITRIDE AND TANTALUM BOROCARBIDE MATERIALS SYSTEMS. Second Quarterly Report. Gerard J. Forney and J. J. Marshall (Electro-Thermal Industries, Inc., Pearl River, N. Y.). Jan. 1961. Contract DA-30-069-ORD-3126. 34p.

An investigation was made of the composition and processing conditions for the production of titanium boronitride and tantalum borocarbide systems with optimum properties for solid propellant rocket nozzle applications. Data are included on the effects of composition on properties, machining qualities of various compositions, and density of various compositions. Successful firings were made at all compositions and reactor pressures. (C.H.)

**32552** (Y-1366) METAL HYDRIDES FOR SHIELDING APPLICATIONS. C. W. Hamill, F. B. Waldrop, and H. T. Kite (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). Oct. 6, 1961. Contract W-7405-eng-26. 15p.

Tests were conducted to determine the behavior of lithium hydride and calcium hydride under a variety of conditions. Metals of interest as container materials were subjected to stress-rupture and tensile tests after undergoing one or more thermal cycles to certain maximum temperatures while in contact with lithium hydride at various lengths of time. Calcium hydride was produced and fabricated, then tested to determine some of its physical properties. (auth)

**32553** (AEC-tr-4466) PROPERTIES OF BETA-HEAT TREATED URANIUM ROD. STUDIES ON URANIUM FUEL ELEMENT. PART V. Kiyooki Taketani. Translated from J. At. Energy Soc. Japan, 2: 6-14(1960). 17p.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 14, abstract no. 9516.

**32554** (JPRS-10232) INVESTIGATION OF THE EQUILIBRIUM IN THE SYSTEM ZIRCONIUM-NITROGEN AT HIGH TEMPERATURES, AND OF THE FREE ENERGY OF FORMATION OF  $\text{ZrN}$  AS A FUNCTION OF ITS COMPOSITION AND STRUCTURE. E. (Ye.) I. Smagina, V. S. Kutsev, and B. F. Ormont. Translated from Problemy Fiz. Khim., No. 2, 118-31(1959). 22p.

A method was developed to study the equilibria in refractory nitrides at 1500 to  $2800^{\circ}\text{K}$ . The equilibrium compositions were established for the  $\text{ZrN}_x - \text{N}_2$  system, for values of  $x$  from 0.7 to 1.0, as a function of temperature and pressure. The decomposition equation,  $\text{ZrN} = \text{Zr} + \frac{1}{2}\text{N}_2$ , was not confirmed at the pressures and temperatures studied. On changes in composition from  $\text{ZrN}_{0.58}$  to  $\text{ZrN}_{1.0}$  the heats of formation vary from 56,100 to 87,900 cal/mol. Conditions of formation were studied and a method was de-

veloped for obtaining zirconium nitrides of the desired composition. (B.O.G.)

**32555** (NASA-TT-F-66) EXPERIMENTAL DETERMINATION OF POTASSIUM VAPOR PRESSURE IN THE  $550^{\circ}$  TO  $1,280^{\circ}\text{C}$  TEMPERATURE RANGE. N. S. Grachev and P. L. Kirilov. Translated from *Inzhener.-Fiz. Zhur.*, Akad. Nauk Belorus. S.S.R., 3: No. 6, 62-5 (June 1960). 7p.

Equipment for measuring the vapor pressure of potassium is described, and results of determinations in the temperature range 550 to  $1280^{\circ}\text{C}$  are plotted as a function of temperature. The results are lower by about 20% than the data of Makansi, Muendel, and Selke. The curve is fitted by the equation  $\log P_s = -4,970/T - 0.5 \log T + 6.160$ , where  $P_s$  is the pressure in atm and  $T$  the temperature in  $^{\circ}\text{K}$ . (D.L.C.)

**32556** (NP-tr-780) AN INVESTIGATION OF THE CHROMIUM-NICKEL-NIOBIUM TERNARY SYSTEM. V. N. Svechnikov and V. M. Pan. Translated from *Issledovaniya po Zharoproch. Splavam*, Akad. Nauk S.S.S.R., Inst. Met. im. A. A. Baikova, 6: 240-50(1960). 16p.

The investigation was conducted to plot the boundaries of the phase zones of the chromium-nickel-niobium alloy limited to that portion of the concentration triangle between a line for the binary chromium-nickel alloys and a line connecting intermetallic compounds  $\text{NbCr}_2$  and  $\text{Ni}_3\text{Nb}$ . The results indicated no eutectoid transformation in the chromium-nickel alloy. An anomalous variation in volume was found to occur when certain alloys of the chromium-nickel alloys, quenched from  $1310^{\circ}\text{C}$ , are tempered. The boundaries of the phase intervals in an isothermal cross section of the phase diagram of the ternary alloy were plotted for  $1100^{\circ}\text{C}$ . (B.O.G.)

**32557** (NP-tr-782) DEEP STABILIZATION AS A METHOD OF INCREASING THE LONG-TERM HEAT RESISTANCE AND DUCTILITY OF ALLOYS. E. E. Levin (Ye. Ye. Lebin) and E. (Ye.) M. Pivnik. Translated from *Issledovaniya po Zharoproch. Splavam*, Akad. Nauk S.S.S.R., Inst. Met. im. A. A. Baikova, 6: 195-200(1960). 8p.

A discussion is given to illustrate possibilities of a method of heat treatment for high-temperature alloys for use as parts in modern gas and steam turbines. The hot strength of nickel-base alloys is found to be in direct relation to the degree of stabilization of the alloys by prior heat treatment. A radical method of achieving the required stabilization of these alloys is a multiple-step stabilization replacing the ordinary heat treatment. (B.O.G.)

**32558** X-RAY STUDIES ON SOLID SOLUTIONS OF OXYGEN IN  $\alpha$ -ZIRCONIUM. Bo Holmberg and Tore Dagerhamn (Univ. of Stockholm). *Acta Chem. Scand.*, 15: 919-25(1961). (In English)

The solubility of oxygen in  $\alpha$ -zirconium in the temperature region,  $400-800^{\circ}\text{C}$ , was investigated by x-ray methods. The solubility, which is independent of temperature, is 28.6 at. % ( $\text{ZrO}_{0.46}$ ). With increasing oxygen content, the length of the  $c$  axis increases over the entire solubility range while that of the  $a$  axis passes through a maximum at the composition  $\text{ZrO}_{0.25}$ . In the solubility range there exist two phases,  $\text{ZrO}_{0+x}$ , with randomly distributed oxygen atoms, and  $\text{Zr}_3\text{O}_{4+y}$ , with partly ordered oxygen atoms. At the limiting composition ( $\text{ZrO}_{0.33}$ ), the oxygen atoms are completely ordered ( $\text{Zr}_3\text{O}$ ). (auth)

**32559** A NOTE ON THE STRUCTURE OF  $\text{Zr}_2\text{Co}$ . D. M. Bailey and J. F. Smith (Ames Lab., Ames, Iowa). *Acta Cryst.*, 14: 1084(Oct. 10, 1961). (In English)

Weissenberg and precession diffraction data from a sin-



gle crystal of  $Zr_2Co$  were found to corroborate the Strukturbericht Type C16 ( $CuAl_2$ ) structure. The single structural parameter was determined as  $x = 0.1679 \pm 0.0019$ , and the tetragonal lattice parameters:  $a_0 = 6.363 \text{ \AA}$  and  $c_0 = 5.469 \text{ \AA}$ . Isotropic temperature factors,  $B_{Co} = 4.08 \text{ \AA}^2$  and  $B_{Zr} = 3.06 \text{ \AA}^2$ , were obtained and are rather large. (P.C.H.)

**32560** THE CRYSTAL STRUCTURE OF  $Ce_7Ni_3$ . R. B. Roof, Jr., Allen C. Larson, and Don T. Cromer (Los Alamos Scientific Lab., N. Mex.). *Acta Cryst.*, 14: 1084-7 (Oct. 10, 1961). (In English)

Using Mo  $K\alpha$  x rays and a precession camera, the crystals were found to be hexagonal with  $a = 9.92 \pm 0.02$  and  $c = 6.33 \pm 0.02 \text{ \AA}$ . With two  $Ce_7Ni_3$  per unit cell the calculated density is  $7.12 \text{ g cm}^{-3}$ . The space group is  $P6_3mc$ ,  $P6_2c/mmc$ , or  $P6_2c$ . For intensity data, sets of timed exposures for each of the levels  $h0l$ ,  $hhl$ , and  $h1l$  were made with a precession camera and Mo  $K\alpha$  radiation. Results of the least squares calculated, observed and calculated structure factors, and the interatomic distances are tabulated. (P.C.H.)

**32561** THE COMPOUND  $Li_2MgPb$ . William J. Ramsey (Univ. of California, Livermore). *Acta Cryst.*, 14: 1091-2 (Oct. 10, 1961). (In English). (UCRL-6257-T)

The compound,  $Li_2MgPb$ , was prepared, and its structure and melting point determined. The compound is brittle, has a metallic blue color, and tarnishes in a matter of minutes in laboratory air. The measured and calculated weight percentages of the elements are: Li,  $5.71 \pm 0.06$ , 5.66; Mg,  $9.99 \pm 0.02$ , 9.91; and Pb,  $84.1 \pm 0.3$ , 84.43. A congruent melting point of  $859^\circ\text{C}$  was measured for the compound. The true melting point of the pure compound is probably within  $10^\circ\text{C}$  of this value. X-ray diffraction powder patterns showed the compound to have a face-centered cubic structure. (P.C.H.)

**32562** THE PHASE  $D1O_2$  TYPE IN THE THORIUM-RHODIUM ALLOY SYSTEM. Riccardo Ferro and Gabriella Rambaldi (Università, Genoa). *Acta Cryst.*, 14: 1094 (Oct. 10, 1961). (In English)

The results obtained in the preparation of some thorium-rhodium alloys with high thorium percentages are presented. The structure corresponds to the  $D1O_2$  type or  $Th_7Fe$  type with the atomic positions referring to the ideal composition  $Th_7Rh_3$ . The calculated density is  $11.7 \text{ g cm}^{-3}$ , and the structure is confirmed by good agreement between observed and calculated intensities. The structural characteristics, the constants ( $\text{\AA}$ ), and the molar volumes ( $\text{cm}^3$ ) are tabulated. (P.C.H.)

**32563** THE PHASE C16 TYPE IN THE THORIUM-PALLADIUM ALLOY SYSTEM. Riccardo Ferro and Renzo Capelli (Università, Genoa). *Acta Cryst.*, 14: 1095 (Oct. 10, 1961). (In English)

The formation of a phase corresponding to the structural C16 type was observed in the thorium-rich part of the system. The powder photographs of alloys with compositions around 18% Pd show the existence of a tetragonal phase with constants:  $a = 7.33$ ,  $c = 5.93 \text{ \AA}$ ,  $c/a = 0.80$ . The microscopic appearance agrees with the hypothesis of the existence of only one phase for a composition near the theoretical one for  $Th_2Pd$  (18.69% Pd); also the density ( $11.5 \text{ g cm}^{-3}$ , for an alloy containing 19.4% Pd and 80.6% Th) appears in fair agreement with the calculated value. The unit-cell dimensions ( $\text{\AA}$ ) and the molar volumes ( $\text{cm}^3$ ) are tabulated. (P.C.H.)

**32564** A DIFFUSIONLESS  $UC_2$  (CUBIC) TO  $UC_2$  (TETRAGONAL) TRANSFORMATION. Roger Chang (Atomics International, Canoga Park, Calif.). *Acta Cryst.*, 14: 1097-8 (Oct. 10, 1961). (In English)

The characteristic features of the diffusionless transformation for  $UC_2$  are described. The transformation from the  $UC_2$  cubic to  $UC_2$  tetragonal lattice can be visualized if the tetragonal lattice is reindexed by a  $45^\circ$  rotation along the  $c$  axis so that  $c' = c$  and  $a' = a/\sqrt{2}$ . The transformation from the  $UC_2$  cubic lattice ( $a_0 = 5.41 \text{ \AA}$  at  $1820^\circ\text{C}$ ) to the reindexed  $UC_2$  tetragonal lattice ( $a = 5.20$ ,  $c' = 5.88 \text{ \AA}$  at  $1820^\circ\text{C}$ ) is then similar to that of  $ZrH_2$  or  $TiH_2$ . Recent high temperature x-ray diffraction data confirm the co-existence of two cubic UC and  $UC_2$  phases near  $2000^\circ\text{C}$ . The experimental observations made are in agreement with other previous predictions. (P.C.H.)

**32565** SURFACE PROPERTIES OF LIQUID SODIUM AND SODIUM-POTASSIUM ALLOYS IN CONTACT WITH METAL OXIDE SURFACES. D. H. Bradhurst and A. S. Buchanan (Univ. of Melbourne). *Australian J. Chem.*, 14: 397-408 (Aug. 1961).

Dissolved oxygen was shown to be surface active in liquid sodium from measurements of surface tension and of contact angle of the liquid on various oxide surfaces. When sufficient oxygen was present wetting of  $UO_2$  by liquid sodium was brought about at temperatures above approximately  $300^\circ\text{C}$ . Observations on the wetting of several solid oxides by sodium gave some support to the hypothesis that wetting was more effective on these oxides with larger cations. Sodium-potassium alloys showed non-wetting contact angles when relatively free of oxygen but wetting occurred when the oxygen content of the liquid was increased. (auth)

**32566** SURFACE PROPERTIES OF MOLTEN BISMUTH-BISMUTH CHLORIDE IN CONTACT WITH URANIUM DIOXIDE. D. H. Bradhurst and A. S. Buchanan (Univ. of Melbourne). *Australian J. Chem.*, 14: 409-16 (Aug. 1961).

The wetting of uranium dioxide by liquid bismuth was investigated by means of measurements of surface tension of the liquid and contact angle of the liquid on the solid. Bismuth chloride in low concentration was found to be a very effective surface active agent in improving the wetting of the solid by the metal. (auth)

**32567** SURFACE PROPERTIES OF LIQUID METALS: BISMUTH, LEAD-BISMUTH, TIN. D. H. Bradhurst and A. S. Buchanan (Univ. of Melbourne). *Australian J. Chem.*, 14: 417-19 (Aug. 1961).

Dissolved oxygen was shown to have inappreciable surface activity in liquid bismuth up to  $700^\circ\text{C}$ . Introduction of lead as a third solute in the liquid bismuth however increased the surface activity of oxygen. The solutes oxygen, sulfur, selenium, and tellurium showed the same order of surface activity in liquid tin as in liquid lead. (auth)

**32568** URANIUM MONOCARBIDE. G. A. Meerson, R. B. Kotelnikov, and S. N. Bashlykov (Basclykov). *Ing. nucleare*, 4: 105-9 (May-June 1961). (In Italian)

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 15, abstract no. 11550.

**32569** PHASE EQUILIBRIA IN SYSTEMS INVOLVING THE RARE EARTH OXIDES. PART III. THE  $Eu_2O_3$ - $In_2O_3$  SYSTEM. S. J. Schneider. *J. Research Natl. Bur. Standards*, 65A: 429-34 (Sept.-Oct. 1961).

The equilibrium phase diagram was determined for the  $Eu_2O_3$ - $In_2O_3$  system. An induction furnace, having an iridium crucible as the heating element (susceptor), was used to establish the solidus and liquidus curves. The 1:1 composition melts congruently at  $1745 \pm 10^\circ\text{C}$ . Melting point relations suggest that the 1:1 composition is a compound with solid solution extending both to 31 mole %  $In_2O_3$  and 71 mole %  $In_2O_3$ . The compound is pseudohexagonal with  $a_H = 3.69 \text{ \AA}$  and  $c_H = 12.38 \text{ \AA}$ . Isostructural phases also

occur in the 1:1 mixtures of both  $Gd_2O_3$  and  $Dy_2O_3$  with  $In_2O_3$ . The melting points of  $Eu_2O_3$  and  $In_2O_3$  were determined to be  $2240 \pm 10^\circ C$  and  $1910 \pm 10^\circ C$ , respectively. A eutectic occurs in the  $Eu_2O_3$ - $In_2O_3$  system at  $1730^\circ C$  and about 73 mole %  $In_2O_3$ . The indicated uncertainties in the melting points are conservative estimates of the over-all inaccuracies of temperature measurement. (auth)

**32570** CONTRIBUTION TO THE STUDY OF ELECTROCRYSTALLIZATION IN FUSED SALTS. APPLICATION TO THE PARTICULAR CASE OF ZIRCONIUM. R. Winand (Université, Libre, Brussels). *Mém. sci. rev. mét.*, 58: 25-35 (Jan. 1961). (In French)

An attempt is made to establish the validity of H. Fischer's theories on electrocrystallization in fused salts. The electrolysis of a mixture of sodium chloride and zirconium tetrafluoride is studied, the metal deposited at the cathode being obtained in the solid state. To connect the crystalline forms observed with electrode mechanisms, the structure of the electrolyte which contains stable complex anions is studied, and the cathodic and anodic polarization curves are plotted with the aid of a photographic recording method, which uses a silver-wire reference electrode. The experimental results can be interpreted by Fischer's theories. Finally, the experimental conditions which should permit the production of a continuous deposit are derived. (auth)

**32571** ON CERTAIN MECHANISMS OF ION BOMBARDMENT. Pierre Haymann (C.N.R.S., Bellevue, France). *Mém. sci. rev. mét.*, 58: 73-9 (Jan. 1961). (In French)

An attempt is made to show by examples of bombardment of metal surfaces with argon ions of 3 to 20 kev that the mechanism of this bombardment can vary with the specimen. Thus the influence of the thermal effects and residual atmosphere around the specimen during the bombardment is determined. When corrosion is due primarily to the ions, the action of the ions is selective and permits certain crystallographic planes and directions to be revealed. (auth)

**32572** MICROGRAPH FRACTURE STUDY OF THE PRECIPITATE FORMED BY ANNEALING AT  $300^\circ C$  OF THE  $\gamma$  PHASE IN U-Mo ALLOYS. H. Mikailoff (Centre d'Etudes nucléaires, Saclay, France). *Mém. sci. rev. mét.*, 58: 171-5 (Mar. 1961). (In French)

Micrograph examination of the fracture surfaces of a U-Mo alloy with 6.3 wt % of molybdenum, quenched in  $\gamma$  phase and annealed at low temperature in order to eliminate pearlitic transformation, has shown that the alloy was fractured by the presence of a submicroscopic uranium precipitate; the fracture occurred by cleavage even at temperatures above room temperature. After coalescence treatment of the precipitate, the fracture becomes intergranular. Uranium  $\alpha$  particles formed during low-temperature annealing were revealed on the fracture surfaces. (auth)

**32573** ELECTRO-CHEMICAL BEHAVIOR OF ZINC-ZIRCONIUM ALLOYS IN THE PRESENCE OF FUSED CHLORIDES. C. Decroly and R. Vaghar (Université, Libre Brussels). *Mém. sci. rev. mét.*, 58: 215-25 (Mar. 1961). (In French)

The electrochemical behavior of zinc-zirconium alloys was studied by determining the electromotive force of galvanic cells which comprise an alloy electrode, a pure metal electrode (zinc or zirconium), and an electrolyte made up of a eutectic mixture of potassium chloride and lithium chloride. When the galvanic chain comprises an alloy electrode and a pure zinc electrode, stationary electromotive forces can be obtained. These forces correspond to the different phases which can be found in the alloy and they confirm the presence of the series of zinc-zirconium combinations proposed by Kilp. The free enthalpies calcu-

lated on the basis of the electromotive force values measured are in good agreement with those which can be established on the basis of vapor pressure determination. (auth)

**32574** URANIUM—0.1% CHROMIUM ALLOY. H. Aubert (Centre d'Etudes nucléaires, Saclay, France). *Mém. sci. rev. mét.*, 58: 276-84 (Apr. 1961). (In French)

An inquiry is made into the heat treatment which gives the most favorable properties and particularly the finest alpha grain. The properties of this alloy between 20 and  $600^\circ C$  are then described: physical and mechanical properties, effect of heat cycling and irradiation in the nuclear reactor. After isothermal quenching, the alloy has clearly improved properties compared with non-alloyed uranium. (auth)

**32575** INFLUENCE OF HEAT TREATMENTS ON URANIUM MONOCARBIDE UC AND SINTERED U-UC. A. Acary and R. Lucas (Centre d'Etudes nucléaires, Saclay, France). *Mém. sci. rev. mét.*, 58: 383-7 (May 1961). (In French)

Uranium monocarbide specimens prepared by sintering under load show marked grain coarsening produced by isothermal heat treatment. The kinetics of the phenomenon between 950 and  $1700^\circ C$  have shown that it falls into two successive stages. (auth)

**32576** THE METASTABLE GAMMA PHASES IN URANIUM ALLOYS CONTAINING MOLYBDENUM. K. Tangri (Atomic Energy Establishment, Trombay, India). *Mém. sci. rev. mét.*, 58: 469-78 (June 1961). (In French)

Uranium alloys containing up to 10% Mo, quenched from a temperature in the gamma range, can be called alloys of the alpha-phase type, since the structures of the metastable phases obtained show only slight modifications with respect to the orthorhombic lattice of alpha uranium. Alloys containing more than 10% Mo can be called gamma-phase alloys since the structures produced after quenching from the gamma range are related to the body-centered cubic structure of this phase, which is stable at an elevated temperature, for pure uranium. X-ray diffraction patterns are shown for a certain number of gamma-phase alloys. Reflections of superstructures are revealed in alloys containing from 10 to 20% Mo. It is shown that the  $\gamma$ -phase obtained in alloys containing approximately 10 to 12% Mo is tetragonal. The structure of this phase is established and a suggestion is made to explain the mechanism of its formation. Experimental verification of this hypothesis is given and the results of the theory of alloys applied to uranium. (auth)

**32577** EFFECT OF Ti, Be, Ga, Re, AND Nb ADDITIONS ON GRAIN SIZE OF ALUMINUM. A. P. Belyaev and R. M. Gol'shtein. *Metalloved. i Termichesk. Obrabotka Metal.*, No. 7, 37-8 (July 1961).

Since a coarse-grained structure results when an aluminum alloy plated with aluminum is heat-treated and recrystallized at  $500^\circ C$  to remove a 7 to 15% deformation, the effect of beryllium, gallium, rhenium, niobium, and titanium additions on grain refining is evaluated. The addition of 0.2% titanium prevents formation of coarse-grained structure above 15% deformation. The addition of only 0.1% of titanium allowed coarse-grained structure at 15% deformation. Addition of 0.05 to 0.5% beryllium, 0.05 to 0.2% niobium, or 0.1 to 0.5% gallium did not reduce the grain size at 1.5 to 15% deformation. With the addition of 0.2% rhenium the coarse-grained structure is not observed until 15% deformation. Addition of 0.05 to 0.1% rhenium had no beneficial effect on grain size. (N.W.R.)

**32578** LOW-TEMPERATURE PHASE TRANSITION IN ALPHA URANIUM. E. S. Fisher (Argonne National Lab.,



III.) and H. J. McSkimin. *Phys. Rev.*, 124: 67-70 (Oct. 1, 1961).

A phase transition in alpha uranium at  $42^\circ\text{K} \pm 1^\circ\text{K}$  is indicated by measurements of the single-crystal elastic moduli using ultrasonic pulse techniques. The indicated transition coincides closely to anomalies noted in the thermal expansion, Hall coefficient, electrical resistivity, and thermoelectric power. An examination of the literature specific heat data shows that the transition is associated with an inflection point in the entropy vs temperature curve. On the basis of the elasticity and available lattice parameter data it is postulated that the temperature dependence of the  $y$  positional parameter becomes relatively large in this range and the phase instability is a result of a change in the nature of certain interatomic bonds. (auth)

**32579** TWO-PHOTON EXCITATION IN  $\text{CaF}_2:\text{Eu}^{2+}$ . W. Kaiser and C. G. B. Garrett (Bell Telephone Labs., Inc., Murray Hill, N. J.). *Phys. Rev. Letters*, 7: 229-31 (Sept. 15, 1961).

A crystal of  $\text{CaF}_2$  containing 0.1%  $\text{Eu}^{2+}$  is illuminated by red light at  $\lambda_r = 6943 \text{ \AA}$  from a ruby maser. The crystal emits blue light at  $\lambda_b = 4250 \text{ \AA}$ . It is found that the relative intensity of the blue and red light is given by  $I_b = \text{constant} \cdot I_r^2$ . It is suggested that the  $\text{Eu}^{2+}$  absorbs two red photons from the maser and emits one blue photon. (T.F.H.)

**32580** DE HAAS-VAN ALPHEN EFFECT IN RHENIUM, NIOBIUM, AND TANTALUM. A. C. Thorsen and T. G. Berlincourt (Atomics International, Canoga Park, Calif.). *Phys. Rev. Letters*, 7: 244-7 (Sept. 15, 1961).

The de Haas-van Alphen oscillations in Re, Nb, and Ta single crystals are observed at 1.13 to  $1.16^\circ\text{K}$ . The periods, Fermi surface extremal cross sectional areas, and effective masses are measured for these oscillations. (T.F.H.)

**32581** THE ELECTRICAL AND MAGNETIC PROPERTIES OF THE URANIUM-NIOBIUM SYSTEM. L. F. Bates and R. D. Barnard (Univ. of Nottingham, Eng.). *Proc. Phys. Soc. (London)*, 78: 361-9 (Sept. 1, 1961).

The magnetic susceptibilities and electrical resistivities of a series of  $\gamma$ -phase uranium-niobium alloys were measured over the temperature ranges 293 to  $1200^\circ\text{K}$  and 90 to  $1200^\circ\text{K}$ , respectively. The form of the resistivity-temperature-concentration relations is abnormal, especially at low temperatures, where negative temperature coefficients of resistivity occur in the uranium-rich alloys, and no explanation can be found in terms of localized moments on either U or Nb atoms. Comparison is made of the same properties of the  $\gamma$  U-Mo alloys and particular attention is directed towards the electronic band structure of niobium. A rigid band model is shown to be appropriate for dilute solid solutions of uranium and molybdenum, but such a model is not applicable to the uranium-rich  $\gamma$  U-Mo and the U-Nb alloys. (auth)

**32582** TYPES OF MELT DIAGRAMS OF BINARY SYSTEMS FORMED BY RADIUM CHLORIDES AND ALKALI METALS. V. R. Klokman. *Radiokhimiya*, 3: 302-8 (1961). (In Russian)

The critical value of  $(\mu\text{Me}^{2+}/\mu\text{Me}^+)$  (below which compounds would not form) was found by correlating the melt diagrams of binary systems formed by alkali chlorides and alkaline earth metals and by the relation of cation moments of the metals. The types of melt diagrams formed by  $\text{RaCl}$  and alkali metals are predicted on the basis of the critical relation of moments of corresponding ions. (R.V.J.)

**32583** WETTING OF Mo BY VARIOUS SILICATE MELTS. S. S. Kayalova. *Zhur. Priklad. Khim.*, 34: 1357-9 (June 1961). (In Russian)

Molybdenum wetting by various silicate melts was studied by the sessile drop method at up to  $1500^\circ\text{C}$  in various gaseous media. Melts containing lead did not show good results even with additions of Sb, O, and  $\text{TiO}_2$ . Wetting with cations was improved with reduced cation radius:  $\text{K} \rightarrow \text{Na} \rightarrow \text{Li}$  and  $\text{Ba} \rightarrow \text{Be}$ . The best results were achieved with combined  $\text{TiO}_2$  and  $\text{B}_2\text{O}$  melts. (R.V.J.)

**32584** REPORT ON PHYSICAL PROPERTIES OF METALS AND ALLOYS FROM CRYOGENIC TO ELATED TEMPERATURES. ASTM Special Technical Publication No. 296. E. A. Eldridge and H. W. Deem. Philadelphia, American Society for Testing Materials, 1961. 209p. \$4.75.

The physical properties of aluminum, cobalt, iron, magnesium, molybdenum, and nickel and their alloys are presented for the temperature range  $-457$  to  $4500^\circ\text{F}$ . (N.W.R.)

**32585** SYMPOSIUM ON METHODS OF METALLOGRAPHIC SPECIMEN PREPARATION. Presented at the Sixty-third Annual Meeting, American Society for Testing Materials, Atlantic City, N. J., June 28, 1960. ASTM Special Technical Publication No. 285. Philadelphia, American Society for Testing Materials, 1961. 140p. \$4.50.

Eight papers are included; one was abstracted separately. One paper was previously abstracted in *NSA*. The papers include both reviews of established methods and reports of new techniques, many of which were developed for preparation of some of the newer metals, alloys, and ceramic materials used in aerospace and nuclear applications. (N.W.R.)

**32586** SIMPLIFIED METALLOGRAPHIC TECHNIQUES FOR NUCLEAR REACTOR MATERIALS. F. M. Cain, Jr. (Nuclear Materials and Equipment Corp., Apollo, Penna.). p.37-57 of "Symposium on Methods of Metallographic Specimen Preparation. ASTM Special Technical Publication No. 285." Philadelphia, American Society for Testing Materials, 1961.

Simple and versatile methods of preparing some of the more common reactor materials for metallographic examination are described. Chemical polishing develops the microscopic structural characteristics of a metal in a few minutes without the use of mechanical or electrolytic polishing. Attack polishing, a method which incorporates the simultaneous application of polishing abrasive and dilute acid solution to the polishing lap, is very useful in preparing materials that have a tendency to smear and flow during mechanical polishing. Cathodic vacuum etching reveals microscopic structures due to the selective removal of atoms by positive ion bombardment from a cathodic specimen in a glow discharge. Electrolytic polishing and the use of diamond abrasive are also playing important roles in metallographic preparation of reactor materials. (auth)

**32587** CERAMICS, PHYSICAL AND CHEMICAL FUNDAMENTALS. Hermann Salmang. Translated by Marcus Francis. London, Butterworths, 1961. 390p. \$12.50.

A critical review of the results of ceramic research is presented. Such topics are discussed as the structure and properties of silicates and glasses, the chemistry and physics of clays, and the arrangement of the ceramic products from the chemical standpoint. Discussion of ceramic technology is kept to a minimum, and descriptions of plants and equipment are omitted. (N.W.R.)

**32588** IMPROVEMENTS RELATING TO ZIRCONIUM ALLOYS. Thomas Raine and James Alan Robinson (to Associated Electrical Industries Ltd.). British Patent 873,884. Aug. 2, 1961.

A Zr alloy suitable for use in aqueous media at high temperatures, e.g., in pressurized or boiling water reactors, is one containing 0.75 to 1.25 wt % Cu and 0.25 to 0.75 wt % Sn, the balance being Zr and impurities. The preferred alloy contains 1.0 wt % Cu and 0.5 wt % Sn and was found to have a weight gain of 1.2 mg/cm<sup>2</sup> after exposure to steam at 1 atm and 500°C for 450 hr, as compared to a weight gain of 7.8 mg/cm<sup>2</sup> for Zircaloy-2 under the same conditions. (D.L.C.)

**32589** STEELS WITH A HIGH BORON CONTENT. (to Compagnie des Ateliers et Forges de la Loire). French Patent 1,184,120. Feb. 2, 1959.

A constructional boron steel for reactors which contains 4 to 4.5% B, 2.5 to 3.5% Si, 0.02 to 0.10% C and less than 0.5% Mn is described. The silicon enables the forging and laminating of the steel despite its high boron content. (NPO)

**32590** IMPROVEMENTS IN NUCLEAR REACTOR ELEMENTS. (to Société Anonyme d'Etudes et Réalisations Nucléaires). French Patent 1,238,281. July 4, 1960.

The utilization of silica, silicon carbide, or any other material which possesses, besides a low neutron capture cross section and a good radiation resistance, a high permeability to infrared radiation, as containment material for fuel is discussed. This enables heat transfer to be principally effected by radiation and makes a good thermal contact between the fuel and its container unnecessary. The proposed material can be applied as constructional material for core tubes through which fuel passes by gravity. Proposed fuel elements consist of a tube of the proposed material in which fuel rings or fuel containing graphite containers, together with Al<sub>2</sub>O<sub>3</sub> spacer rings, are piled up. If required the silica tubes can be reinforced with a stainless steel grating. (NPO)

**32591** IMPROVEMENTS IN FUEL SLUGS FOR NUCLEAR REACTORS. (to Combustion Engineering). French Patent 1,250,985. Dec. 5, 1960.

The fuel consists of a solid solution of 5 to 55 mol % UO<sub>2</sub> in CeO<sub>2</sub> or stabilized ZrO<sub>2</sub>. It is stated that this type of fuel is less subject to dimensional changes and fissuring and so enables a higher burnup to be achieved. (NPO)

## Radiation Effects

**32592** (ANL-6368(p.107-9)) THE TEMPERATURE OF NEUTRON-IRRADIATED SUBSTANCES. T. R. Sato and H. H. Strain (Argonne National Lab., Ill.).

When P compounds were exposed to neutrons at a high flux, the activation products varied with the nature of the containers. This variation was traced to thermal reactions resulting from the absorption of neutrons by small quantities of B in the containers themselves. Data are presented on the relationship among neutron flux, composition of containers, and temperature. Ampoules of lime glass, B-free glass, quartz, and polyethylene were irradiated. Results indicate that pure quartz or polyethylene are the most desirable materials for containers. (C.H.)

**32593** (IBM-61-928-26) STUDY OF EFFECT OF HIGH-INTENSITY PULSED NUCLEAR RADIATION ON ELECTRONIC PARTS AND MATERIALS (SCORRE). Report No. 4. Quarterly Progress Report No. 4, April 1, 1961 to June 31, 1961. (International Business Machines Corp., FSD Space Guidance Center, Owego, N. Y.). Contract DA-36-039-SC-85395. 42p.

The pulse responses of ferrite and tape-wound cores used for memory and logic applications were observed during exposure to bursts of nuclear radiation from the Sandia Pulsed Reactor (SPR). Test samples included ferrite toroid

and two-aperture memory cores, ferrite and 4-79 permalloy switch cores, and a tape-wound core used for magnetic logic applications. A static test of a small memory plane consisting of two-aperture ferrite cores was also conducted. No pulsed radiation effects were detected in most test samples. Two Disturb Test samples showed variations that may be due to radiation on some undetermined test circuit malfunction. Mn-Zn ferrite switch cores showed variations during the SPR burst, indicating that this material may be sensitive to pulsed radiation. (auth)

**32594** (NP-10775) MONTHLY ACCESSION LIST 50 [ON RADIATION EFFECTS DATA], AUGUST 1 THROUGH AUGUST 31, 1961. (Battelle Memorial Inst. Radiation Effects Information Center, Columbus, Ohio). Sept. 15, 1961. 25p.

A bibliography of 63 references with abstracts is presented, subdivided into the following sections: miscellaneous and general interest, electronics, space, polymeric materials, organic and inorganic chemistry, metals and ceramics, dosimetry, and facilities. (D.L.C.)

**32595** (NP-10818) EFFECT OF GAMMA RADIATION AND OXYGEN AT AMBIENT TEMPERATURES ON THE SUBSEQUENT PLASTICITY OF BITUMINOUS COALS. Frank Rusinko, Jr., Allan Weinstein, and P. L. Walker, Jr. (Pennsylvania State Univ., University Park. Mineral Industries Experiment Station). May 6, 1959. 28p. (SR-10)

The effect of radiation on bituminous coal in the presence of varying amounts of oxygen at ambient temperature has been investigated. Following irradiation, the amount and analysis of the residual gas remaining above the coals have been determined. Fluidities of the coals have been measured, both before and after irradiation, with a Gieseler plastometer. The consequences of radiation are found to be markedly affected by the nature of the starting coal and amount of oxygen in contact with the coal during irradiation. (auth)

**32596** (NP-10819) RADIATION STABILITY OF A COAL TAR PITCH. Anton Roeger, III, J. A. Hammond, and P. L. Walker, Jr. (Pennsylvania State Univ., University Park. Mineral Industries Experiment Station). June 25, 1959. 109p. (SR-13).

A high-temperature coal-tar pitch was irradiated to  $3.5 \times 10^8$  rads. Approximately 90% of the energy absorbed came from gamma rays and 10% from fast neutrons. Samples were sealed either under a vacuum or under an atmosphere of air and irradiated at less than 50°C. Two techniques were developed to detect effects of radiation on chemical and physical properties of the pitch. They were: viscosity measurement, and infrared analysis of the structure of the irradiated pitch. Additional methods used to evaluate radiation-induced changes were: mass spectrometric analysis of the evolved gas, and x-ray diffraction analysis of the structure of the irradiated pitch. All measurements indicate that the high-temperature coal-tar pitch underwent negligible changes in its physical and chemical properties upon irradiation up to the maximum dosage employed. (auth)

**32597** (NP-10821) EFFECT OF ANTHRACITE AND GAMMA RADIATION AT AMBIENT TEMPERATURES ON THE SUBSEQUENT PLASTICITY OF BITUMINOUS COALS. Frank Rusinko, Jr. and P. L. Walker, Jr. (Pennsylvania State Univ., University Park. Mineral Industries Experiment Station). Aug. 5, 1959. 18p. (SR-15)

The effect of radiation on blends of anthracite and bituminous coal in the presence of an atmosphere of air has been investigated. Fluidities of the coals have been meas-



ured with a Gieseler plastometer. Fluidities are found to decrease upon addition of anthracite. The further consequences of radiation on the fluidity of the coal blends are found to be dependent upon the starting bituminous coal.

(auth)

**32598** (NP-10833) FINAL DEVELOPMENT REPORT FOR EVALUATION-DEVELOPMENT OF MIL-C-14157B CAPACITORS FOR NUCLEAR RADIATION ENVIRONMENTS. (Admiral Corp., Chicago). Aug. 21, 1961. Contract NObsr-77612. 128p.

In the first environmental test, 75% failure occurred: in the steady voltage irradiated group, 56 hours; in the cycled voltage irradiated group, 120 hours; in the steady voltage control group, 123 hours; and in the cycled voltage control group, theoretically 1086 hours. In the second environmental test, 75% failure occurred: in the steady voltage irradiated group, 144 hours; in the cycled voltage irradiated group, 107 hours; in the steady voltage control group, 560 hours; and in the cycled voltage control group, 650 hours. The principal causes of failure discovered as a result of the environmental test of the standard CPM08 capacitor were: gas evolution and a volume resistivity decrease of the dielectric fluid, embrittlement of the Kraft paper, and hydrolytic degradation of the Mylar. Bendix E-200 capacitors performed exceptionally well in the environmental test with insignificant change in capacitance and dissipation factor. This was also the case for Samica dielectric film capacitors impregnated with inhibited monoisopropylbiphenyl dielectric fluid or C-oil resin. The Samica dielectric film units with silicone resin impregnant exhibited the best survival rate; however, changes in capacitance, dissipation factor and insulation resistance in the irradiated group were excessive. Isocyanate treated Mylar units failed very rapidly. It appears that the Mylar was not properly prepared to take advantage of the improved properties of the isocyanate treatment of Mylar. (auth)

**32599** NUCLEATION AND GROWTH OF GAS BUBBLES IN IRRADIATED METALS. B. S. Hickman (Australian Atomic Energy Commission Research Establishment, Sydney). J. Australian Inst. Metals, 5: No. 2, 173-81 (Aug. 1960).

Several metals undergo nuclear reactions when subjected to neutron irradiation which result in the formation of gases in the metal. At elevated temperatures these gases tend to nucleate and form gas bubbles which result in over-all increases in volume in the material, and which can have important technological implications. The available experi-

mental data on this phenomenon are summarized, attention being concentrated on the cases of krypton and xenon in uranium and helium in beryllium. Current theories of nucleation and growth, developed for the case of the rare gases in uranium, are reviewed. Some comments are made on the application of these theories to beryllium. (auth)

**32600** OBSERVATION OF THE TRACKS OF FISSION FRAGMENTS IN MOLYBDENITE. Kazuhiko Izui and F. Eiichi Fujita (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan, 16: 1779 (Sept. 1961). (In English)

Features of fission fragment tracks in molybdenite crystal were observed with an electron microscope, enabling a detailed analysis of the thermal spike region. (L.N.N.)

**32601** MOLECULAR DISARRAY IN A CRYSTAL LATTICE PRODUCED BY A FISSION FRAGMENT. F. P. Bowden and L. T. Chadderton (Cavendish Lab., Cambridge, Eng.). Nature, 192: 31-4 (Oct. 7, 1961).

It was found possible to make a direct observation of the molecular disarray produced in a crystal lattice when a single fission fragment passes through it. The extent of the damage can be measured to within one molecular plane, and in platinum phthalocyanine was found to vary between seven and twenty (20 $\bar{1}$ ) planes, being dependent on where, and at what angle, the fragment strikes the crystal. In some cases dislocation dipoles are formed. The method appears to be perceptive for studying the detailed mechanisms of radiation damage. (P.C.H.)

**32602** THE INFLUENCE OF IMPURITY ATOMS ON THE ANNEALING KINETICS OF ELECTRON IRRADIATED COPPER. D. G. Martin (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phil. Mag.(8), 6: 839-46 (July 1961). (AERE-R-3577)

Spectroscopically pure copper and three dilute copper alloys containing approximately 0.05 atomic % of silver, cadmium and beryllium respectively were irradiated with 4 Mev electrons at -196°C and then annealed at temperatures up to +50°C. The recovery of the irradiation damage was observed by measuring changes in electrical resistance, measured in liquid helium. Three annealing peaks at approximately -140°, -80° and 0°C were observed in the spectroscopically pure copper. Similar peaks occur also in the dilute alloys, but their exact form is significantly altered. A tentative explanation consistent with a widely held description of the annealing stages in irradiated copper is put forward. (auth)

# PHYSICS

## General and Miscellaneous

*Refer also to abstract 32997*

**32603** (AFOSR-1380) THE INITIAL VALUE PROBLEM, SOUND PROPAGATION, AND MODELING IN KINETIC THEORY. Lawrence Sirovich (New York Univ., New York. Inst. of Mathematical Sciences). Sept. 15, 1961. Contract AF49(638)-1006. 91p. (MF-17).

The one dimensional initial value problem of a monatomic single component gas was considered. Using the linearized Boltzmann equation the dispersion relation was studied. In addition to the usual gas dynamic sound waves an infinity of decaying propagating waves was found. The phenomenon naturally exhibited itself as a sequence of epochs, the last stage of which was hydrodynamic. With reference to the same problem macroscopic equations such as Euler, Navier-Stokes, Burnett, Grad's moments equations, etc., were considered. The recently considered "kinetic models" of Gross et al. were also applied to the problem. These various formulations were critically analyzed and compared with each other and with the Boltzmann analysis. Several alternate molecular and macroscopic equations are offered which remedy some of the shortcomings which appear in the above mentioned approximate theories. (auth)

**32604** (AFOSR-1433) LOW TEMPERATURE ELECTRON TRAPPING LIFETIMES AND EXTRINSIC PHOTOCONDUCTIVITY IN N-TYPE SILICON DOPED WITH SHALLOW IMPURITIES. Technical Note No. 1. R. Levitt and A. Honig (Syracuse Univ., N. Y. Research Inst.). Aug. 1, 1961. Contract AF49(638)-966. 33p.

The trapping lifetimes of conduction electrons photoexcited from shallow impurities were measured in the liquid helium temperature range for samples of n-type silicon whose donor and compensating acceptor concentrations varied from  $10^{13}$  to  $10^{16}$  impurities/cm<sup>3</sup>. A steady state method was employed, in which the conduction electron lifetime  $t_L$  was equal to  $n_e \tau^i / N_D^0$ .  $n_e$  is the conduction electron concentration which is determined from low temperature photo-Hall measurements, and  $N_D^0 / \tau^i$  is the electron generation rate. The neutral donor concentration  $N_D^0$  was measured by the Hall effect and  $\tau^i$ , the lifetime against photoionization of a neutral donor, was obtained directly by an electron spin resonance technique. The trapping lifetimes  $t_L$  were generally independent of temperature between 4.2°K and 1.2°K, and were inversely proportional to the compensating acceptor concentration. This latter was determined using a recently developed combined infrared radiation and spin resonance method. The trapping cross-section result for phosphorus donors was about  $5 \times 10^{-12}$  cm<sup>2</sup> at 3°K. This was about an order of magnitude larger than the value obtained from the giant trap theory of M. Lax. Also, the concentration independence of the cross-section in the region of temperature independent  $t_L$  was not easily accounted for. The mobility of electrons photoexcited with 2 micron radiation considerably exceeded the mobility of electrons photoexcited with 8 to 25 micron radiation. This suggested the possibility of excitation to another band or minimum by the 2 micron radiation, as was also suggested by the free carrier absorption peak near 2 microns found in n-type silicon by Spitzer and Fan. (auth)

**32605** (APEX-746) THERMOELECTRIC STABILITY TESTS. R. J. Freeman (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). July 31, 1961. Contracts AF33(600)-38062 and AT(11-1-171. 31p.

Fuel element thermocouple development is discussed. Thermoelectric stability tests were conducted at 2000°, 2200°, 2400°, 2600°, and 2800°F. Decalibrations were seen to increase with increasing temperature. Flame-sprayed bare wire and the Duax configuration showed indications of very favorable stability. There were indications that the less pure, more economical, and more readily applied alumina for flame-spray work provides thermoelectric stability as good as, or better than, the high purity materials. Zirconia, used exclusively as an insulator for thermocouples, exhibited such low electrical resistivity at high temperature as to result in prohibitive errors. Alumina flame-spray spalling problems were also observed. (auth)

**32606** (NAVORD-7130) MASS SYSTEMATICS AND ASSEMBLAGE THEORY. Russell G. Herron (Naval Nuclear Ordnance Evaluation Unit, Albuquerque, N. Mex.). Nov. 16, 1960. 53p. (AD-255290).

An assemblage theory of matter is presented that depicts elementary particles and atomic nuclei as assemblages of point-like discontinuities in a quantized nuclear field. On the basis of the theory, new particles are predicted; it is argued that the proton and neutron are simply different energy states of the same assemblage. The mean life of the neutron was calculated accurately. A heuristic mass formula containing four quantized parameters was used to calculate the masses of all elementary particles and isotopes having  $A < 34$ . The mass of the electron was calculated to be  $548.7674169... \times 10^{-6}$  amu. Nuclear I spin values are predicted for thirty-five light isotopes. It is hypothesized that the masses of all elementary particles and nuclei are systematic and quantized. (auth)

**32607** (NP-10834) RECENT ADVANCES IN HIGH PRESSURE, HIGH POWER ARCS. J. W. Reid (General Electric Co. Flight Propulsion Lab. [Dept.], Evendale, Ohio). [1961]. 19p.

Paper No. 1217 for presentation at American Rocket Society Space Flight Report to the Nation, New York Coliseum, October 9-15, 1961.

Progress made in the electric arc field toward solutions of some of the common problems with the electrothermal propulsion field is reviewed. Gas ejection and electromagnetic motion methods of obtaining clean flow are described. The relative value of a-c and d-c power is discussed. The effects of pressure on arcs are outlined. The problem of minimizing turbulence in plasma generating devices is discussed. (M.C.G.)

**32608** (NP-10857) DUKE MICROWAVE LABORATORY REPORT NO. 34, JULY 1, 1961-SEPTEMBER 30, 1961. (Duke Univ., Durham, N. C.). 77p. Contract AF49(638)-765. Includes papers: ELECTRON SPIN RESONANCE OF AN IRRADIATED SINGLE CRYSTAL OF DEUTERATED DL-TARTARIC ACID. D. V. G. L. Narasimha Rao and Walter Gordy. ELECTRON SPIN RESONANCE IN A GAMMA-IRRADIATED SINGLE CRYSTAL OF DIGLYCOLIC ACID MONOHYDRATE. Yukio Kurita. ELECTRON-MOLECULE AND ELECTRON-ATOM COLLISION CROSS-SECTIONS FROM A CYCLOTRON RESONANCE STUDY OF FLAME GASES. E. M.



Bulewicz. ELECTRON-MOLECULE COLLISION CROSS-SECTIONS IN THE BURNED GASES OF A VARIETY OF FUELS. E. M. Bulewicz and P. J. Padley.

The electron spin resonance spectra of an irradiated single crystal of deuterated DL-tartaric acid were determined. Measurements were made at 9 and 23 kMc/sec. Single crystals of diglycolic acid monohydrate were grown from water and irradiated. The electron spin resonance of the irradiated crystals was measured at 9.04 kMc. Electron-gas molecule collision cross sections were determined for  $N_2$ , Ar, He, and Ne in acetylene-oxygen flames from a cyclotron resonance study. The electron collision cross sections for  $H_2O$  and  $CO_2$  were found to be  $80 \pm 4A^2$  and  $37 \pm 2A^2$ , respectively in flames at about 2200°K. This conclusion was tested by extending the measurements of collision frequency to other fuels. (M.C.G.)

**32609** (NP-10858) THE DESIGN OF ELECTROSTATIC GENERATORS FOR OPERATION IN SPACE. F. J. McCoy, C. N. Coenraads, and A. S. Denholm (Goodrich-High Voltage Astronautics, Inc., Burlington, Mass.). [1961]. 25p.

Presented at the American Rocket Society Space Flight Report to the Nation/New York Coliseum, October 9-15, 1961.

Conceptual designs for electrostatic generators for space applications are described. Energy exchange processes, machine selection, capacitance design considerations, and practical electric field strengths are discussed. Minimum and maximum voltages that can be attained by the electrostatic generators are considered. An analysis of the generator cycle is presented. (M.C.G.)

**32610** (NP-10860) ASTRONAUTICS INFORMATION. OPEN LITERATURE SURVEY, VOL. IV, NO. 3, ENTRIES 40,454-40,728. E. M. Carringer, M. G. Hoppe, and B. H. Nichols, comps. (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Sept. 1961. 48p. Contract NASw-6.

An open literature survey dealing with astronautics covering the period of September 1961 is presented. A compilation was made of 274 references on space flight and applicable data and techniques. Author, subject, and periodical indexes are included. (M.C.G.)

**32611** (NP-10862) RESEARCH ON THE PHENOMENA OF SUPERCONDUCTIVITY IN METALS AND ALLOYS. Quarterly Progress Report Nos. 6 and 7 covering Period September 1, 1960-May 31, 1961. W. H. Cherry, G. D. Cody, J. Gittleman, and J. J. Hanak-F. D. Rosi and G. D. Cody, eds. (David Sarnoff Research Center, Princeton, N. J.). May 31, 1961. Contract AF33(616)-6405. 27p.

Measurements of the Kapitza resistance of tin and its change at the superconducting transition temperature are reported. Crystalline deposits of  $Nb_3Sn$  and  $Ta_3Sn$  were prepared for the first time. These deposits exhibited superconducting properties similar to sintered material. The resistance anomaly in the  $\beta$ -tungsten compounds is shown to be independent of the method of sample preparation and would appear to be a bulk characteristic. Critical fields measured on  $\beta$ -tungsten compounds are shown to depend on the method of sample preparation. In particular, for sintered specimens, the magnetic behavior depends on the particle size and degree of sintering. (auth)

**32612** (TID-13452) OUTPUT RESISTANCE OF THE HALL GENERATOR. Bill J. Harper (New Mexico. Univ., Albuquerque. Engineering Experiment Station). July 1961. For Sandia Corp., Albuquerque, N. Mex. 13p. (SCDC-2390)

In investigations of the electrical properties of the Hall Generator used as a linear circuit element, it was neces-

sary to determine the open-circuit output impedance  $R_{22}$ . The approach taken was to reduce the problem to two dimensions and then to use the techniques of conformal mapping to transform the geometry of the Hall Generator into a form more suitable for calculating the output resistance. The Schwartz-Christoffel transformation was used. The calculated value of  $R_{22}$  was in good agreement with measured values. (M.C.G.)

**32613** (TID-13905) SNAP-8, THE FIRST ELECTRIC PROPULSION POWER SYSTEM. P. I. Wood, D. L. Forrest, and B. M. Wilner (Aerojet-General Corp., Azusa, Calif.). [1961]. Contract [AT(10-1)-880]. 18p.

Paper No. 2050-61 for presentation at American Rocket Society, Space Flight Report to the Nation/New York Coliseum, October 9-15, 1961.

The SNAP-8 Electrical Generating System is a nuclear-turbo-electric space power plant which is ideally suited for utilization with electric propulsion. Several applications, the program objectives, the over-all system, and the design of the major components are described. The program status is delineated and future plans leading to an early flight test and equipment endurance demonstration are defined. (auth)

**32614** (TID-13923) TOTAL X-RAY ATTENUATION COEFFICIENTS FROM 40 Kev TO 412 Kev. M. Wiedenbeck (California Inst. of Tech., Pasadena). [1961]. 11p.

The total x-ray attenuation coefficients for a variety of materials were measured in the energy range between 40 and 412 kev. The unique angular and energy resolution of the DuMond curved crystal spectrometer were employed in the analysis of the scattered radiation. (auth)

**32615** (TID-13926) STATISTICAL THEORY OF SURFACE TENSION. Technical Report No. XLI. Seihun Chang, Taikyue Ree, Henry Eyring, and Ingrid Matzner (Utah. Univ., Salt Lake City. Inst. for the Study of Rate Processes). Sept. 30, 1961. Contract AT(11-1)-82. 20p.

The surface tensions of liquid argon, nitrogen, and methane at various temperatures were calculated applying the method of significant structures in liquids. The Eötvös constants for these liquids were also calculated. The results showed good agreement with experimental observations. Further, these calculations showed that only the top two layers of a liquid contribute to the surface tension near the melting point. At higher temperatures, however, more layers contribute significantly, i.e., the transition zone between the gas and liquid phases becomes broader with increasing temperature. (auth)

**32616** (NP-tr-764) INTRODUCTION TO ROCKET TECHNOLOGY. V. I. Feodos'ev (Feodosyev) and G. B. (Ye.) Sinyarev. Translated from p.44-8; 58-84; 167-76; 211-36; 460-86 of Vvedeniye v Raketnuyu Tekhniku (A publication of the State Scientific-Technical Publishing House, Moscow, 1960). 135p.

A general review is presented on both Russian and foreign rockets. The types of rockets discussed include long-range rockets, anti-aircraft rockets, anti-rocket missiles, rocket-propelled flying craft, and rockets for space and meteorological research. The theory and combustion of solid and liquid rocket fuels are considered in detail. Finally, launching systems and ground equipment are discussed mainly for military rockets. (D.L.C.)

**32617** (SCL-T-382) APPLICATION OF THE GENERALIZED SCHUSTER TEST TO THE HARMONIC ANALYSIS OF THE AZIMUTHS OF THE PARACONICAL PENDULUM. Maurice Allais. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.) from Compt. rend., 245: 2467-70 (Dec. 23, 1957). 5p.

The application of a generalization of the Schuster test to the results given by the harmonic analysis of the azimuth of the paraconical pendulum showed that an explanation on the basis of purely fortuitous causes of the existence within the experimental data of a wave with a period close to 25h and with an amplitude equal to that found, has a very slight probability. (auth)

**32618** (UCRL-Trans-721(L)) ON THE EQUATION OF STATE AT ZERO TEMPERATURE OF THE RARE GAS ATOMS Ne, Ar, Kr, and Xe. P. Gombas and O. Kunvari. Translated by Stephen G. Brush (Univ. of California Lawrence Radiation Lab., Livermore) from *Acta Phys. Acad. Sci. Hung.*, 5: 339-45(1955). 7p.

On the basis of the statistical model of the atom, extended with exchange and correlation corrections, the equation of state at absolute zero temperature is derived for the rare gases Ne, Ar, Kr, and Xe. (D.L.C.)

**32619** X-RAYS ACCOMPANYING THE MAGNETIC STORM OF JUNE 27, 1960. R. R. Brown (Univ. of California, Berkeley). *Arkiv Geofysik*, 3: No. 21, 435-9(1961). (In English)

A burst of x rays was observed at balloon altitude with the sudden onset of a geomagnetic storm on June 27, 1960. Electron bombardment of the upper atmosphere gave rise to the x rays and occurred on a large scale. Associated ionospheric disturbances were observed at College, Alaska and Kiruna, Sweden. (auth)

**32620** THE INFLUENCE OF Cd ON THE ABSORPTION OF NaCl. J. Kantůrek and K. Suk (Inst. of Technical Physics, Czechoslovak Academy of Sciences, Prague). *Czechoslov. J. Phys.*, 11B: 579-83(1961). (In Czech)

Absorption measurements on uncolored and x-irradiated crystals of NaCl with different Cd concentrations were made to show under what conditions the "non-active" form of this impurity may become the "active" form. (auth)

**32621** THERMODYNAMIC PROPERTIES OF FLUID FLOW ACROSS A MAGNETIC FIELD. I. J. Singh (Oil and Natural Gas Commission, Dehradun, India) and K. P. Chopra. *Indian J. Phys.*, 35: 271-7(June 1961).

The various thermodynamic quantities involved in the flow of a conducting fluid in a uniform transverse magnetic field are studied. The analogs of Rayleigh and Fanno lines are readily derived from the basic equations. The internal energy and enthalpy of an electrically conducting fluid obeying perfect gas depends on its density and the strength of the magnetic field. The entropy and the specific heat at constant volume do not seem to be affected by the presence of the magnetic field. The behavior of the specific heat at constant pressure depends on which of the gas pressure and the total pressure is kept constant. A transverse magnetic field reduces the specific heat at constant gas pressure and the corresponding adiabatic constant by a factor proportional to the ratio of the magnetic pressure to the gas pressure. However, if the total pressure is kept constant, the magnetic field has no effect on the specific heat. The effect of the magnetic field on the velocity of sound is discussed. In the limiting cases of weak and strong magnetic fields, the velocity of sound reduces to the ordinary sonic speed and the Alfvén speed, respectively. (auth)

**32622** INTERMOLECULAR POTENTIALS OF  $H_2$  AND  $D_2$ . I. B. Srivastava and A. K. Barua (Indian Assn. for the Cultivation of Science, Jadvpur, Calcutta). *Indian J. Phys.*, 35: 320-2(June 1961).

An investigation of the intermolecular potentials of hydrogen and deuterium is carried out in order to test the results obtained by Michels, De Graaff, and Ten Seldam.

The second virial coefficient,  $B(T)$ , data of Michels, De Graaff, and Ten Seldam is fitted into the exp-six model by taking into consideration the quantum effects. The results show that the force fields of hydrogen and deuterium are not exactly the same. The agreement of the experimental data calculated on the exp-six model from the force constants is very good over the entire temperature range (-175 to 150°C). Hence, further consideration of the non-spherical nature of the potentials may not be necessary. (N.W.R.)

**32623** ON THE R CENTERS IN LITHIUM FLUORIDE. Akizo Okuda (Kyoto Univ.). *J. Phys. Soc. Japan*, 16: 1746-62(Sept. 1961). (In English)

In colored LiF crystals, two bands at 320 and 378 m $\mu$  were investigated and assigned as  $R_1$  and  $R_2$  bands by the correspondences to R bands in other alkali halides. Intensity ratio of the  $R_1$  band to the  $R_2$  band is almost constant irrespective of irradiation conditions of  $\beta$  or  $\gamma$  rays as well as of photochemical treatments. Both the bands are bleached by irradiation with either  $R_1$  or  $R_2$  light, where the former has a higher efficiency for the bleaching. The results support the interpretation that  $R_1$  and  $R_2$  bands are due to transitions in the same center. Emission spectra by excitation with  $R_1$  and  $R_2$  lights are distinct: the latter has a peak at 495 m $\mu$  and the former at 730 m $\mu$  or above. By polarized R lights, dichroism is induced in the  $R_1$ ,  $R_2$  and M bands and also polarization of the emissions is observed. Then symmetries of the models which were proposed as complexes of F centers are examined by the experimental results and it is considered that  $F_3$ -model lying in [111] plane is the most adequate for R center. In addition to characteristic M-center luminescence, which has a peak at 710 m $\mu$  and value of 0.6 for  $P[011]$ , an emission band at 525 m $\mu$  is observed by M-light excitation but P-factor for this emission is less than that of the M-center luminescence. (auth)

**32624** SCINTILLATION FROM THE SOLID XENON. Sigeo Takemoto, Takeo Hasegawa, and Saburo Homma (Tôhoku Univ., Sendai). *J. Phys. Soc. Japan*, 16: 1777(Sept. 1961). (In English)

Xenon gas was frozen by liquid air and the scintillation pulse from the solid xenon due to  $Po^{210}$  alpha particles was measured with an electronic system consisting of a DuMont 6291 photomultiplier, a cathode follower, and an Iwasaki 30-Mc synchroscope. It was found that the scintillation spectrum of the solid xenon might be considered to be in the sensitive part of the photomultiplier. The decay time for the solid xenon was found to be less than  $6 \times 10^{-8}$  sec. (L.N.N.)

**32625** REFLECTION OF A WEAK SHOCK WAVE IN A PERFECTLY CONDUCTING GAS. Shigeki Morioka (Kyoto Univ.). *J. Phys. Soc. Japan*, 16: 1794-5(Sept. 1961). (In English)

Regular reflection of a weak plane shock wave propagating in a homogeneous, perfectly conducting gas from a solid wall, in the presence of a uniform magnetic field parallel to the wall, is discussed. A mathematical derivation is presented. It is found that the presence of the magnetic field tends to enlarge the range of the shock angle in which regular reflection can occur. (L.N.N.)

**32626** SPECIFIC HEAT AND EXPANSION COEFFICIENT OF LIQUID HELIUM-3 UNDER PRESSURE BELOW 0.1°K. D. F. Brewer and J. R. G. Keyston (Clarendon Lab., Oxford). *Nature*, 191: 1261-3(Sept. 23, 1961).

Measurements of the specific heat were carried out at constant pressure,  $C_p$ , at several atmospheres, and be-



tween the temperature limits 0.04 and 0.35°K. There was no indication of any anomaly in the specific heat. The change in temperature on adiabatic expansion and compression of the liquid near the melting pressure was also measured. The mean expansion coefficient (over a range of pressure and temperature) was always negative between 0.04 and 0.32°K. The reversal in sign of the pressure dependence of the specific heat at about 0.16°K was confirmed, and positive values of  $(\partial C_p/\partial p)_T$  were found down to 0.04°K. However, the specific heat was still not linear at the lowest temperature. (P.C.H.)

**32627 RADIO-LUMINESCENCE IN SODIUM CHLORIDE AND POTASSIUM CHLORIDE.** S. B. Hyder and B. K. Gupta (Osmania Univ., Hyderabad, India). *Nature*, 192: 60-1 (Oct. 7, 1961).

The production and quenching of luminescence in pure and additively colored crystals of NaCl and KCl, excited by x rays from a copper target, are reported. In both crystals the luminescence output was found to rise steeply in the first few minutes and to fall slowly to the saturation value as more and more luminescent centers were destroyed. The luminescence output plotted against x-ray intensity at different times of exposure show that as the time of exposure increased, the slope decreased. Preliminary results with a number of alkali halides, pure and additively colored, using the photon-counting technique, showed similar behavior with NaCl and KCl. KI showed very fast quenching with virtually no phosphorescence, whereas KBr gave excellent response but long lasting phosphorescence. The deterioration of luminescence efficiency was almost exponential in KCl and rather slow in NaCl, showing that quenching centers are produced in KCl faster than in NaCl. (P.C.H.)

**32628 MAGNETIC FIELD OF ALTERNATELY CHARGED SYMMETRIC MULTIPOLE MAGNET.** Masateru Sonoda, Akira Katase, Masao Seki, and Tsunekazu Akiyoshi (Kyushu Univ., Fukuoka). *Nuclear Instr. & Methods*, 12: 349-52 (July 1961). (In English)

The magnetic field of an alternately charged symmetric 2N-pole magnet is calculated, using the conformal transformations. The formulas are given for the equipotential line, the line of force, the field strength, the magnetomotive force and the total magnetic flux passing through the surface of a pole piece. (auth)

**32629 REFRACTIVE INDEX OF SOLID KRYPTON AND SOLID ARGON.** B. L. Smith (Univ. of London). *Phil. Mag.* (8), 6: 939-42 (July 1961).

The refractive index of solid krypton was determined at 71 to 109°K using simple oxygen cryostat and spectrometer. The specimen was condensed into a hollow perspex prism and the refractive index was determined by the method of minimum deviation. The density of solid argon was re-determined at 77 to 83°K by a bulk-density method. This compared favorably with previous results, thus the refractive index value previously obtained was considered reliable. Results are graphically represented. Assuming that the specific influence of temperature is small, it appears that the Lorentz—Lorenz function increases with increasing density for both solids. (L.N.N.)

**32630 EFFECT OF MAGNETIC FIELD AND ROTATION ON KELVIN-HELMHOLTZ INSTABILITY.** Z. Alterman (Yerkes Observatory, Williams Bay, Wis.). *Phys. Fluids*, 4: 1207-10 (Oct. 1961).

The combined effect of a horizontal magnetic field and rotation on Kelvin-Helmholtz instability of a stratified fluid is considered. In two uniform fluids the short-wave perturbations are stabilized by magnetic field and surface

tension, while rotation has a second-order effect. In the long-wave range the magnetic field increases the effect of rotational instability. Stability of fluids with exponentially varying density is discussed. (auth)

**32631 TEMPERATURE DEPENDENCE OF THE THERMAL DIFFUSION FACTOR FOR HELIUM, NEON, AND ARGON.** S. C. Saxena (Atomic Energy Establishment, Trombay, India), J. G. Kelley, and W. W. Watson. *Phys. Fluids*, 4: 1216-25 (Oct. 1961).

The isotopic thermal diffusion factor for He, Ne, and Ar was measured by an all-glass "swing separator" with its lower tube ends at 78 and 195°K, extending the temperature range of earlier data. These new data, along with the older ones, were interpreted in terms of the L-J (12-6) and modified exp-six potentials. Various equilibrium and non-equilibrium properties are calculated and compared with the experimental data. An equation was developed which relates the thermal diffusion factor with the absolute values of the viscosity, diffusion coefficient, and their derivatives and is essentially independent of the nature of intermolecular force. The thermal diffusion values are consistent with the available experimental data of viscosity and diffusion, through the use of the proposed relation, but more accurate data on diffusion as a function of temperature are needed for a precise evaluation. Approximate calculations are given to estimate the quantum corrections for He at 78 and 195°K. (auth)

**32632 APPARENT VISCOSITY OF A CHARGED FLUID.** Otmar M. Stuetzer (General Mills, Inc., Minneapolis). *Phys. Fluids*, 4: 1226-31 (Oct. 1961).

Charges in a liquid or gas, under the influence of a self-created or applied field, increase the viscous losses. The general equations for a macroscopic electrohydrodynamic treatment of this phenomenon are given. Steady-state channel flow and a simple dynamic situation are theoretically investigated and compared with the magnetohydrodynamic cases. Some experiments are described. (auth)

**32633 COEFFICIENT OF DYNAMIC FRICTION FOR SLOW IONS.** S. Rand (Convair, San Diego, Calif.). *Phys. Fluids*, 4: 1251-8 (Oct. 1961).

The coefficient of dynamic friction for a subsonic ion is determined, in a phenomenological manner, by requiring that the drag force acting on a test particle in a plasma be identical with the drag force on a field particle. The drag coefficient is determined in both a fully ionized gas and in a specialized partially ionized gas. The effects of collisions between ions and neutral particles on the drag force is considered. It is found that, with some rather special conditions, the stopping power on a charged particle traversing a plasma may be reduced when the density of neutral particles is increased. (auth)

**32634 VALIDITY OF THE NONLINEAR POISSON-BOLTZMANN EQUATION.** Nandor L. Balazs (Princeton Univ., N. J.). *Phys. Fluids*, 4: 1259-61 (Oct. 1961). (MATT-75)

The validity of the nonlinear and linearized Poisson-Boltzmann equation is analyzed by comparing analytically and numerically the correct equation of state of a one-dimensional plasma with the approximate ones following from the Poisson-Boltzmann equation. (auth)

**32635 DISPERSION RELATIONS IN A STATIONARY PLASMA.** B. Samuel Tanenbaum (Raytheon Co., Wayland, Mass.). *Phys. Fluids*, 4: 1262-72 (Oct. 1961).

The two-fluid theory for a fully ionized, macroscopically neutral plasma is used to examine small-amplitude normal mode oscillations in an infinite, homogeneous medium for three cases: no applied magnetic field; a magnetic field in

the direction of wave propagation; and a magnetic field perpendicular to the direction of wave propagation. In the field-free case, which was treated in a similar way by Pai, the dispersion relations for the three simplest types of plasma oscillations—longitudinal electron waves, longitudinal ion waves, and transverse waves—are verified and the properties of each of these waves are described. In the second and third cases, the influence of an applied magnetic field on the normal mode solutions is studied and the results of this complete two-fluid theory are compared with analogous results obtained in the simpler theories of Appleton (magneto-ionic theory) and of Alfvén (magnetohydrodynamics). (auth)

**32636 HALL EFFECT IN A LORENTZ GAS.** G. W. Sutton (General Electric Space Sciences Lab., Philadelphia). *Phys. Fluids*, 4: 1273-6(Oct. 1961).

For a Lorentz gas, expressions are derived for the direct and transverse electron electrical conductivities for an arbitrary inverse-power interaction force with the heavy particles. The results are compared to the simple kinetic model for the electron motion. It is found that the simplified equation is not general for small magnetic fields but is correct for large magnetic fields. For inverse powers greater than 3, the error is less than 15%. (auth)

**32637 DIFFUSION FROM A SLIGHTLY IONIZED REGION IN A UNIFORM FLOW.** A. C. Pipkin (Univ. of Maryland, College Park). *Phys. Fluids*, 4: 1298-1302(Oct. 1961).

A simplified version is treated of the problem of charge diffusion from the ionized gas behind an infinite plane shock wave in steady motion. The main features of the results are independent of the mechanism of ionization. A charged double layer appears at the upstream edge of the region in which ionization takes place. The electric field between the positive and negative layers is strong enough to prevent any large number of electrons from diffusing far upstream. (auth)

**32638 TRANSONIC FLOW IN A MAGNETOHYDRODYNAMIC GENERATOR.** D. T. Swift-Hook (Central Electricity Research Labs., Leatherhead, Eng.). *Phys. Fluids*, 4: 1316-17(Oct. 1961).

It is shown that a decelerating "tunnel" for the one-dimensional flow of a conducting gas in crossed electric field can be shifted wholly into the generator region (or wholly into the motor region) of the field by using a divergent (or convergent) duct, so that it is possible in principle to have a smooth transonic deceleration in a magnetohydrodynamic generator, with the consequent possibility of increased efficiency. (L.N.N.)

**32639 RIGIDITY OF THE INERTIAL MOMENT OF LARGE INTERACTING MANY-FERMION SYSTEMS IN PERTURBATION THEORY.** Ronald M. Rockmore (Brandeis Univ., Waltham, Mass.). *Phys. Rev.*, 124: 27-33 (Oct. 1, 1961).

As a result of an addendum and a correction to the author's previous work, the vanishing of interaction effects on the inertial moment of a large many-fermion system, moving under periodic boundary conditions, in the second order of particle-particle coupling is established. The result is independent of potential form. A proof extending the theorem to all orders is given. (auth)

**32640 MAGNETIC FIELD AT THE NUCLEUS IN SPINEL-TYPE CRYSTALS.** W. H. Kelly (Michigan State Univ., East Lansing), V. J. Folen, M. Hass, W. N. Schreiner, and G. B. Beard. *Phys. Rev.*, 124: 80-4 (Oct. 1, 1961).

Measurements of the magnetic field at the  $\text{Fe}^{57}$  nucleus

were obtained on powder samples at room temperature using the Mössbauer effect for the spinel-type ferrites  $\gamma\text{-Fe}_2\text{O}_3$ , "ordered" lithium ferrite ( $\text{Li}_{0.5}\text{Fe}_{2.5}\text{O}_4$ ), and "disordered" lithium ferrite giving values of  $|496 \pm 20|$  koe,  $|508 \pm 20|$  koe, and  $|510 \pm 20|$  koe. These compounds contain only trivalent and no divalent iron. The Mössbauer spectra of all of these compounds were very similar and no difference could be detected between the "ordered" and "disordered" compounds. Only one set of lines was observed indicating that the fields at the octahedral and tetrahedral sites are about the same value. The value of the hyperfine interaction constant  $A$  obtained from electron paramagnetic resonance spectrum of the divalent  $\text{Mn}^{55}$  (isoelectronic with trivalent Fe) impurity in single crystals of the isomorphous spinel-type crystal "disordered" lithium aluminate ( $\text{Li}_{0.5}\text{Al}_{2.5}\text{O}_4$ ) was found to be  $|77.2 \pm 1.0| \times 10^{-4} \text{ cm}^{-1}$ . The angular variation of the spectrum indicated that the divalent  $\text{Mn}^{55}$  ions were located substantially on octahedral sites. The corresponding magnetic field for the  $\text{Mn}^{55}$  nucleus is around 550 koe, which is close to the value obtained elsewhere for the  $\text{Mn}^{55}$  nucleus located on a tetrahedral site in a spinel-type aluminate. This is in good agreement with the Mössbauer results. (auth)

**32641 ORBITAL CONTRIBUTION TO THE MAGNETIC FORM FACTOR OF  $\text{Ni}^{++}$ .** M. Blume (Atomic Energy Research Establishment, Harwell, Berks, Eng.). *Phys. Rev.*, 124: 96-103(Oct. 1, 1961).

The effect of a residual orbital moment on the magnetic form factor of  $\text{Ni}^{++}$  is calculated. It is shown that the ordinary form factor is replaced by a tensor, and formulas are given for the slow-neutron magnetic-scattering cross sections of paramagnetic, ferromagnetic, and antiferromagnetic  $\text{Ni}^{++}$ . It is found that the unquenched orbital moment causes a 4% expansion of the form factor relative to the "spin-only" case, and that the anisotropic scattering is reduced by about ten percent. (auth)

**32642 ENERGY DISSIPATION BY IONS IN THE kev REGION.** J. Lindhard (Aarhus Univ., Denmark) and M. Scharff. *Phys. Rev.*, 124: 128-30(Oct. 1, 1961).

At low energies ionic collisions with atoms are largely elastic. Simple theoretical approximations to scattering cross sections, ranges, and straggling are derived for power potentials, showing that the scattering is peaked in the forward direction rather than isotropic. Using an approximate universal potential of Thomas-Fermi type a natural measure of range,  $\rho$ , and of energy,  $\epsilon$ , is obtained for all ions in all substances. The corresponding range-energy curve is computed. At higher ion energies the electronic excitation becomes increasingly important. An approximate formula is given for the electronic stopping contribution, increasing proportional to ion velocity at low and moderate velocities. These results are applied in the interpretation of a few isotope effects, observed in range measurements. (auth)

**32643 VARIATIONAL METHOD FOR SCATTERING LENGTH.** Takashi Ohmura (Washington Univ., St. Louis). *Phys. Rev.*, 124: 130-4(Oct. 1, 1961).

The properties of the scattering length obtained by Kohn's method, which is one of Hulthén's variational methods, are studied by assuming a linear trial function with  $n$  adjustable parameters. The scattering length  $A^{(n)}$  decreases monotonically as the number of adjustable parameters  $n$  increases, if there is no bound state in the system. This conclusion essentially comes from the upper bound theorem of Spruch and Rosenberg. When the system has  $m$  bound states, the scattering length increases in value only  $m$  times, and otherwise decreases monotonically. Therefore, after one



verifies the presence of  $m$  increases, the calculated value is certain to give an upper bound on the scattering length. The connection between the result above and the condition of Rosenberg, Spruch, and O'Malley is considered. In the Appendix comparison is made of the scattering length  $A^{(n)}$  obtained by Hulthén's original method and Kohn's method when  $m$  bound states exist in general. (auth)

**32644** SCATTERING OF LOW-ENERGY ELECTRONS BY ATOMIC HYDROGEN. R. H. Neynaber, Lawrence L. Marino, Erhard W. Rothe, and S. M. Trujillo (Convair, San Diego, Calif.). *Phys. Rev.*, 124: 135-6 (Oct. 1, 1961).

The total cross section for the scattering of electrons by atomic hydrogen has been measured as a function of electron energy from 3.1 to 12.3 eV. The basic measurement compared the number of electrons scattered from a region defined by the intersection of an electron beam and a chopped molecular beam with the number scattered when the hydrogen beam was partially dissociated. By measuring the degree of dissociation with a mass spectrometer, one may obtain the ratio of cross sections of atomic and molecular hydrogen for a given energy. The absolute atomic values were calculated from these ratios and molecular hydrogen values obtained from the literature. In the experiment most of the scattered electrons were detected (the angular resolution was about  $25^\circ$ ), thereby differing from a previous measurement by Brackmann, Fite, and Neynaber. The results are in good agreement with several theoretical estimates, e.g., that of McEachran and Fraser. (auth)

**32645** OSCILLATOR FREQUENCY AND VIBRATIONAL QUANTA IN THE HYDROGEN MOLECULE. J. P. Auffray and J. W. Cooley (New York Univ., New York). *Phys. Rev.*, 124: 137 (Oct. 1, 1961).

Theoretical values of the oscillator frequency and vibrational quanta in the electronic ground state of  $H_2$  are obtained and compared with the corresponding experimental data. Agreement between the two sets of values is found to be of the order of 1 part to  $10^3$ . This is somewhat larger than the estimate (2 parts in  $10^4$ ) of the experimental error. (auth)

**32646** ISOTOPE EFFECT IN THE NUCLEAR MAGNETIC RESONANCE IN RUBIDIUM. W. E. Blumberg, J. Eisinger, and M. P. Klein (Bell Telephone Labs., Murray Hill, N. J.). *Phys. Rev.*, 124: 206-7 (Oct. 1, 1961).

By performing precise measurements of the nuclear magnetic resonance frequencies at constant field of the stable Rb isotopes in a metallic sample and in RbCl solution,  $\Delta = k^{85}/k^{87} - 1 = (0.38 \pm 0.03)\%$  was determined, where  $k^{85,87}$  is the Knight shift of  $Rb^{85,87}$ .  $\Delta$  is the hyperfine structure anomaly which will be equal to  $\Delta(s_{1/2})$ , determined from  $Rb(5s\ S_{1/2})$  atomic beam experiments only if the hyperfine interaction responsible for the Knight shift arises from  $s_{1/2}$  conduction electrons. The experimental results show that to high precision this is the case. (auth)

**32647** DENSITY OF LIQUID HELIUM-3 BETWEEN 0.0045 AND 1.3°K. John E. Rives and Horst Meyer (Duke Univ., Durham, N. C.). *Phys. Rev. Letters*, 7: 217-19 (Sept. 15, 1961).

The density ( $\rho$ ) of liquid  $He^3$  is measured at  $T = 0.045$  to  $1.3^\circ K$  and at 0.18 to 28 atm. At 0.18 atm. and below  $0.08^\circ K$ , it is found that the coefficient of expansion  $\alpha = -(0.12 \pm 0.02)/T$ . At about 15 atm. a minimum in  $\rho$  is observed; the temperature of this minimum increases with pressure. (T.F.H.)

**32648** SELF DIFFUSION COEFFICIENT AND NUCLEAR SUSCEPTIBILITY OF LIQUID HELIUM-THREE.

A. C. Anderson, W. Reese, R. J. Sarwinski, and J. C. Wheatley (Univ. of Illinois, Urbana). *Phys. Rev. Letters*, 7: 220-2 (Sept. 15, 1961).

The magnetization self-diffusion coefficient of liquid  $He^3$  is found to equal  $(1.54 \cdot 10^{-6} \text{ cm}^2 \cdot \text{K}^2/\text{sec})T^{-2}$ , below  $T \approx 0.05^\circ K$ . The magnetic susceptibility  $\chi$  is found to be constant below  $0.1^\circ K$ .  $\chi$  is given in terms of  $T^*$ , where  $T^* = [(\chi T)]_{1.153^\circ K}/\chi$ ;  $T^*$  is  $0.347 \pm 0.010^\circ K$ . Measurements are made at 0.02 to  $0.10^\circ K$  and at 120 mm Hg. (T.F.H.)

**32649** ULTRASONIC AMPLIFICATION IN Cds. A. R. Hutson (Bell Telephone Labs., Inc., Murray Hill, N. J.), J. H. McFee, and D. L. White. *Phys. Rev. Letters*, 7: 237-9 (Sept. 15, 1961).

Radiofrequency waves at 15 and 45 Mc are transduced into pressure waves at the same frequencies, and are applied to a CdS crystal. The waves are then converted by a second transducer into a r-f output wave. The signal amplification is found as a function of the illumination intensity on the crystal, and the electric field parallel to the pressure waves. Positive gain may be attained for suitable values of the electric field. (T.F.H.)

**32650** THE SCATTERING OF LOW-ENERGY ORTHO-POSITRONIUM BY HYDROGEN ATOMS. P. A. Fraser (Univ. of Western Ontario, London, Can.). *Proc. Phys. Soc. (London)*, 78: 329-47 (Sept. 1, 1961).

When ortho-positronium collides with a hydrogen atom not only may it be scattered, but there is also the possibility of conversion of the ortho-positronium to para-positronium by electron exchange. The total elastic cross section and the conversion cross section are calculated for positronium kinetic energies 0 to 9.8 eV, for the  $l = 0$  partial wave only. A particular choice of trial wave function explicitly satisfying the Pauli principle and a variational argument lead to integro-differential equations, with no ordinary force, from which the phase shifts are obtained by a numerical method. The cross sections are very strongly energy dependent: the total cross section ranges from  $192\pi a_0^2$  at zero energy to  $2.92\pi a_0^2$  at 6.8 eV, while the (conversion)/(total) ratio ranges from 0.176 to 0.070 over these energies. These ratios are well below the value  $1/4$  expected at high energies from the Born approximation. The total cross section results of Massey and Mohr for this problem using Born approximation were  $230\pi a_0^2$  at zero energy and  $25\pi a_0^2$  at 6.8 eV, with the (conversion)/(total) ratio  $1/4$ . (auth)

**32651** SPACE-TIME CORRELATION FUNCTION IN THE THEORY OF ELECTRICAL CONDUCTIVITY. Isao Mannari (Kyoto Univ.). *Progr. Theoret. Phys. (Kyoto)*, 26: 51-83 (July 1961). (In English)

A formula is given for the electrical resistivity ( $\rho$ ) of metals, using results from excitation-response theory. It is shown that  $\rho$  may be expressed in terms of the four-dimensional Fourier transform of the appropriate pair function, in the space and time of the scattering systems, by which conduction electrons are scattered to lose their initial velocity. The dependence of the electrical conductivity on the effects of the correlation in the scattering system is discussed systematically, by using the correlation functions in some typical examples. Properties of  $\rho$  for the ferromagnetic metals are discussed, using the so-called s-d interaction model. In this case it is shown that the inclusion of the effect of the correlation between d spins gives rise to deviations of  $\rho$  from the value given by the simple molecular field approximation. (auth)

**32652** ON THE THEORY OF PLANE STRESS. Edward L. Reiss and Stanley Locke (New York Univ., New York and Republic Aviation, [New York]). *Quart. Appl. Math.*, 19: 195-203 (Oct. 1961).

The classical theory of plane stress is concerned with a thin elastic plate subjected to edge forces which deform it so that there is no normal displacement of its middle plane. This theory may be obtained from the exact three dimensional linear theory of elasticity for homogeneous and isotropic materials, by neglecting some of the compatibility equations and assuming that the shear and normal stresses, transverse to the middle plane of the plate, vanish and the remaining stresses are independent of  $z$ , the coordinate normal to this mid-plane. Hence, the relationship between the two theories is shown by systematically deriving from the exact theory the differential equations and boundary conditions of plane stress. Each stress component is expanded in a power series in the plate thickness,  $h$ , and equated to determine the expansion coefficients. The plane stress theory appears as the zeroth order interior problem, the solutions of which supply a first approximation to the three-dimensional stress distribution. The expansion procedure also provides three-dimensional corrections to the plane stress theory. (N.W.R.)

**32653** VIBRATION SPECTRA IN ORGANIC PHOSPHOR COMPOUNDS. E. M. Popov, M. I. Kabachnik, and L. S. Mayants (Inst. of Elementary Organic Compounds, Academy of Sciences, USSR). *Uspekhi Khim.*, 30: 846-76 (July 1961). (In Russian)

Data on the interpretation of vibration spectra in organic phosphors, theoretical analysis of vibrations in phosphor-containing molecules, and applications of vibration spectra in resolving certain chemical problems of organic phosphors are reviewed. 132 references. (R.V.J.)

**32654** NON-LINEAR VIBRATION PROBLEMS TREATED BY THE AVERAGING METHOD OF W. RITZ. K. Klotter (Stanford Univ., Calif.). p.125-31 of "Proceedings of the First National Congress of Applied Mechanics." New York, The American Society of Mechanical Engineers.

A method is described which is useful for obtaining quantitative information concerning steady-state vibrations governed by non-linear differential equations. The method or rather the two forms of the method (B. G. Galerkin and W. Ritz) are stated and the Ritz Averaging Method is applied to the forced vibrations of a single-degree-of-freedom system having arbitrary restoring and arbitrary damping forces. The results are given in the closed form of the equations. The results are compared with exact solutions. A few remarks are given about other problems that can and were treated by the method and about extensions in the application of the method as regards higher term approximations and systems of more than one degree of freedom. (N.W.R.)

**32655** HELIUM THREE. Proceedings of the Second Symposium on Liquid and Solid Helium Three, held at The Ohio State University, August 23-25, 1960. John G. Daunt, ed. Columbus, Ohio, Ohio State University Press, 1960. 195p. \$4.50.

The properties of liquid and solid  $\text{He}^3$  and  $\text{He}^3\text{-He}^4$  mixtures are studied. For pure  $\text{He}^3$ , physical and thermal properties, nuclear resonance and relaxation properties, self-diffusion characteristics, nuclear susceptibility, and thermodynamic properties are studied. For mixtures of  $\text{He}^3$  and  $\text{He}^4$ , thermodynamic properties, thermal conductivity, viscosity, sound absorption, osmotic pressure, temperature pulse phenomena, transition temperatures, and theory are examined. (T.F.H.)

**32656** FIELD EMISSION AND FIELD IONIZATION. Robert Gomer. Harvard Monographs in Applied Science, Number 9. Cambridge, Massachusetts, Harvard University Press, 1961. 200p.

The theory of field emission, field ionization, and field desorption are presented and used to serve as an introduction to field and ion microscopy. The discussion is held to an elementary mathematical level, with emphasis on physical significance rather than rigor. Quantum mechanics is used so sparingly that the main arguments can be understood without previous knowledge of that subject. Selected applications are included to illustrate the potentialities of the subject. A description of experimental techniques is presented. (N.W.R.)

**32657** THE BOMBARDMENT OF SURFACES BY POSITIVE IONS. J. H. Leck (Liverpool Univ.). p.162-8 of "Chemisorption." New York, Academic Press Inc. and London, Butterworths Scientific Publications, 1957.

Observations on the adsorption of positive ions with energies up to 5000 ev on to the surfaces of nickel, tungsten, aluminum, and molybdenum are described. The work was carried out under high-vacuum conditions with a mass-spectrometer, so that it was possible to follow the slow desorption of one gas against a large background of some other gas. Measurements were limited to helium, neon, argon, krypton, hydrogen, nitrogen, oxygen, and carbon dioxide. Metal targets were bombarded with positive ions of these gases at known energy for fixed times. In subsequent heating, gas was recovered from the target, showing that it was held at the surface or inside the metal as either ions or neutral molecules. The maximum quantity of gas that can be taken up increased with increasing ion energy to a maximum of approximately that required to form a complete surface layer one atom in depth. Temperatures of the order of 700 to 800°K were required to remove the adsorbed gas, thus showing binding energies much higher than for physical adsorption, especially for the inert gases. It was also noticed that the ions can dislodge, and take the place of any molecules already adsorbed at the surface. (auth)

**32658** SHOCK TUBES. J. K. Wright. Methuen's Monographs on Physical Subjects. London, Methuen & Co. Ltd. and New York, John Wiley & Sons Inc., 1961. 169p. \$2.95.

An account is given of shock tube operation and use in the study of a variety of problems. A simple exposition is also given of shock wave theory, shock wave reflection, refraction and diffraction, and the basic ideas in plasma physics, as well as a detailed account of the instrumental techniques used with shock tubes. (N.W.R.)

**32659** TIME-HARMONIC ELECTROMAGNETIC FIELDS. Roger F. Harrington. McGraw-Hill Electrical and Electronic Engineering Series. New York, McGraw-Hill Book Co., Inc., 1961. 491p.

Mathematical techniques for handling electromagnetic engineering problems are presented. Theorems are derived and proved, and numerous practical examples are given to illustrate the theory. Only sinusoidally time-varying fields are considered. Problems are given at the end of each chapter and in the index; answers are given for most of the problems. Much of the theory can easily be extended to arbitrarily time-varying fields by means of the Fourier or Laplace transformations. (N.W.R.)

**32660** THE FUNDAMENTAL ATOMIC CONSTANTS. J. H. Sanders. Oxford Library of the Physical Sciences. London, Oxford University Press, 1961. 95p.

A concise account is presented on the derivation of the most acceptable values of the atomic constants. There is no criticism of the methods used in deriving the best values of the constants, from the point of view of either the handling of the experimental data or the analytical procedure. (N.W.R.)



## Astrophysics and Cosmology

**32661** (AD-255891) CALCULATIONS OF ELECTRON EXCITATION OF FORBIDDEN LINES OCCURRING IN GASEOUS NEBULAE. Report No. 3. Stanley J. Czyzak (Detroit. Univ.). Mar. 1, 1961. Contract Nonr-2820(00). 55p.

Radial wave functions of the various ions of P, S, Cl, and Ar were determined by the Hartree-Fock method. Results are presented in tabular form. (M.C.G.)

**32662** THE ORIGIN OF THE ELEMENTS. A. G. W. Cameron (Atomic Energy of Canada Ltd., Chalk River, Ont). p.225-42 of "Evolution: Its Science and Doctrine. Symposium presented to the Royal Society of Canada in 1959". Thomas W. M. Cameron, ed. Toronto, University of Toronto Press, 1960. (AECL-980)

Four theories, equilibrium, Mayer-Teller, big bang- $\alpha$ - $\beta$ - $\gamma$ , and stellar formation, on the formation of the elements are discussed. Special attention is given to the theory of stellar formation with some of the essential mechanisms of each of the first three theories appearing in that theory. (P.C.H.)

## Cosmic Radiation

**32663** THE EFFECTS OF ENERGETIC TRAPPED PARTICLES ON MAGNETOSPHERIC MOTIONS AND IONOSPHERIC CURRENTS. J. A. Fejer (Defence Research Board, Theoretical Studies Group, Ottawa). Can. J. Phys., 39: 1409-17(Oct. 1961).

It is shown that the temporary distortion of a previously stable belt of energetic charged particles, trapped in the earth's magnetic field, results in a system of ionospheric currents and magnetospheric motions. The currents are caused by the charge separation which occurs in the course of the subsequent adiabatic motion of the energetic particles. The resulting current system closely resembles the well-known Ds current system. The polarization fields, which drive these currents, give rise to magnetospheric motions similar to those of Axford and Hines and the implications of their work then also result. The distortion of the belt could be caused either directly, by the introduction of a new group of trapped particles mainly on the day side of the magnetosphere, or indirectly, through the relatively sudden compression of the earth's field on the day side, caused by the arrival of a neutral stream of charged particles from the sun. (auth)

**32664** CHANGES IN THE DIURNAL HOUR OF MAXIMUM OF THE COSMIC-RAY INTENSITY. J. Katzman (National Research Council, Ottawa). Can. J. Phys., 39: 1477-85(Oct. 1961). (NRC-6498)

The diurnal hour of maximum of the meson component changed progressively at Ottawa, Canada, from 10 hr 44 min to 14 hr 40 min during the period January 1955 to December 1960 while the nucleon component changed from 12 hr 12 min to 15 hr 16 min for the same period. This evidence favors the 22-year cycle in the diurnal hour of maximum that was first suggested by Thambyahpillai and Elliot, for stations within a geomagnetic latitude belt between 58.1°N and 48.1°S. The diurnal hour of maximum at Churchill changed from 14 hr 40 min to 15 hr 24 min during the period April 1957 to December 1960 for the meson component and from 15 hr 12 min to 15 hr 52 min for the nucleon component. Although the change was for a later hour the indication of a 22-year cycle at Churchill is not impressive. At Resolute the diurnal hour of maximum is dominated by the varying magnetic masses in interplane-

tary space. It is shown that the anisotropy varies both in magnitude and direction depending on the conditions that exist in the solar system. (auth)

**32665** LONGITUDINAL DEPENDENCE OF RADIATION-BELT SCATTERING, AND PRIMARY AURORAL PARTICLES. C. J. Loughnan (Dominion Physical Lab., Omakau, N. Z.). Planetary Space Sci., 8: 13-22(Oct. 1961). (In English)

Due to the geomagnetic field differing from that of a centered dipole, the altitude of the trapped-radiation regions surrounding the earth varies with geomagnetic longitude. In some circumstances this should lead to a marked longitude dependence in the leakage of particles from these regions. This dependence is estimated, and also the precipitation pattern for the outer radiation belt. The conditions for the existence of this variation are discussed, and a consequent difficulty is raised in explaining aurorae as the direct result of leakage from the radiation belt. As a preliminary, a simple method of estimating the altitude of surfaces of constant magnetic field strength is presented. (auth)

## Criticality Studies

**32666** (KAPL-M-JRT-1) REACTIVITY COEFFICIENTS IN PMA-47 A ZIRCONIUM-URANIUM, UNPOISONED SLAB CORE. PART I. MEASUREMENTS. J. R. Tomonto (Knolls Atomic Power Lab., Schenectady, N. Y.). Aug. 21, 1961. Contract W-31-109-Eng-52. 73p.

The results of measuring neutron flux distributions, distributed reactivity coefficients of  $U^{235}$ , polyethylene, and zircaloy as well as the spatially dependent reactivity coefficients of zircaloy, aluminum, and zirconium-boron in PMA-47 are reported. PMA-47 is the second of a series of cores constructed in the Plastic Mockup Assembly (PMA) to provide reactivity coefficients and criticality data in cores with simple geometry. It differs from the first core of the series (PMA-40) in that it contains a higher fuel density and utilizes zirconium as its structural material. The reactivity data will be used to test analytical techniques and to provide a comparison with related values for subsequent similar aluminum-uranium cores. (auth)

**32667** (KAPL-M-RFS-2) TRANSIENT REACTIVITY MEASUREMENT. R. F. Shea (Knolls Atomic Power Lab., Schenectady, N. Y.). Sept. 11, 1961. Contract W-31-109-Eng-52. 27p.

The usual reactor kinetics equations are shown to consist of three major components: a fast term, a product or quotient term, and a summation of transient terms. These can be synthesized by using a number of simple RC networks having time constants related to the fast time constant and to the decay constants of the various groups of delayed neutron emitters, plus either an analog multiplier or divider. A circuit is shown which incorporates these principles, using a diode divider. Curves are given of output reading, indicating transient reactivity, for input currents having constant positive period, obtained from a motor-driven potentiometer. It is shown that these curves are reasonably close to the calculated curves of reactor reactivity for such periods. It is shown that it is also possible to use a logarithmic amplifier plus a time constant network to indicate transient reactivity. Accuracy of indication can be made reasonably good for the first period or two, although the asymptotic values would correspond to inverse period rather than reactivity. (auth)

**32668** (NYO-2678) HETEROGENEOUS REACTOR CALCULATION METHODS. Quarterly Progress Report

No. 6, July 1, 1960–September 30, 1960. Carl N. Klahr, Lawrence B. Mendelsohn, and Jerome Heitner (TRG, Inc., Syosset, N. Y.). Contract AT(30-1)-2375. 108p. (TRG-129-QTR-6)

Results of heterogeneous and homogeneous calculations for natural U rods in a loosely packed graphite lattice are compared, in order to determine the lattice size at which heterogeneous effects become important. HERESY-1 is a code used to calculate reactivities, power distributions, etc. Operating instructions, input-output descriptions, and the FORTRAN source program are presented for this code. HERESY-2 is a code similar to HERESY-1, with the exception that HERESY-2 includes multiple resonance effects. The sensitivity of the HERESY-2 calculations to several variables—the neutron energies at which resonance absorption occurs, the neutron energies at which resonance fission occurs, and the effects of resonance fission on reactivity—is studied. (T.F.H.)

**32669** (PG-Report-257) MINIMUM MASS IN URANIUM–METAL WATER LATTICES. B. G. Owen and H. W. Haskey (United Kingdom Atomic Energy Authority. Production Group, Risley, Lancs, England and United Kingdom Atomic Energy Authority. Engineering Group, Risley, Lancs, England). 1961. 21p.

An empirical method is devised for estimating the critical mass of uranium-235 in a spherical lattice of enriched uranium rods in light water surrounded by an infinite water reflector. (B.O.G.)

**32670** (TID-3306) CRITICALITY. A Bibliography of Unclassified Literature. Raymond L. Scott, comp. (Office of Technical Information Extension, AEC). Mar. 1961. 179p.

A total of 1145 references to unclassified reports and published literature is presented on calculations of critical parameters for various reactor fuels and moderators, critical and exponential experiments, and nuclear safety criteria for processing, handling, and storage of fissionable materials. Author, subject, and report number-availability indexes are provided. (auth)

## Elementary Particles and Radiations

**32671** (AFOSR-205) THE MOTION OF CHARGED PARTICLES IN A RANDOM MAGNETIC FIELD. [Presented at the] Fourth Symposium on Mathematical Statistics and Probability, June 20 to July 30, 1960. J. A. Crawford (California. Univ., Berkeley). July 27, [1960]. 19p. (AD-255779).

The problem of the motion of charged particles in a random magnetic field is discussed. The necessity of simplifying assumptions is shown. Postulates adopted concerning the nature of the random magnetic field and the charged particles moving in it are described. The outline of the problem, the linearized equation of motion, the Fokker-Planck equation, and the Fermi acceleration are discussed. It is shown that departure from time-stationarity affects the theory in a radical manner. (M.C.G.)

**32672** (CX-55) BOUNDS ON ELEMENTS OF THE S MATRIX FOR ELASTIC SCATTERING: ONE DIMENSIONAL SCATTERING. Ralph Bartram and Larry Spruch (New York Univ., New York. Inst. of Mathematical Sciences). June 1961. Contracts AF19(604)4555; DA-30-069-ORD-2581; Nonr-285(49) NR-012-109. 33p. (AFCRL-646)

The elastic multi-channel scattering processes were considered. The Schroedinger equation was cast into a form in which the potential is a real symmetric  $N \times N$  matrix and the wave function is an  $N \times 1$  matrix. Upper and lower bounds on the elements of the S matrix were determined. The procedure in analogy with that of Kato, was to derive an integral variational principle which was in fact an identity and then to bound the explicitly exhibited second order term. Numerical examples were calculated for a one-dimensional attractive square well asymmetric with respect to origin. (M.C.G.)

**32673** (NP-10825) POLARIZATION OF SPIN ONE PARTICLES SCATTERED FROM SPIN ZERO NUCLEI. Technical Report No. 2. Jerome Wesolowski (Washington Univ., St. Louis). Aug. 1961. Contract AF49(638)-843. 33p.

The theory of the polarization of spin-one particles scattered from spin zero nuclei is summarized and related to possible double scattering experiments. (D.L.C.)

**32674** (NP-10826) LIFETIME OF POSITRONS IN LIQUIDS AT HIGH PRESSURE. Final Report. R. K. Wilson, P. O. Johnson, and R. Stump (Kansas. Univ., Lawrence). [1961]. 34p.

The mechanisms of the annihilation of positronium in liquids were studied. The microscopic nature of the liquid state was discussed. The materials studied were: methyl alcohol, ethyl alcohol, isopropyl alcohol, isobutyl alcohol, glycerin, water, benzene, lucite, teflon, and polystyrene. (B.O.G.)

**32675** (NP-10839) MODEL ANOMAL'NOGO VZAIMODEISTVIYA MYUONA. (A Model of Anomalous Interaction of Muon). I. Yu. Kobzarev and L. B. Okun (Akademiya Nauk S.S.S.R. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1961. 20p. (ITEP-61-14)

A model in which the muon and electron masses differ because the muon interacts with a hypothetical  $\chi^0$  meson is analyzed. Possible manifestations of the interaction are discussed. The problem of neutrino, muon, and baryon interactions with  $\chi$  is analyzed. (tr-auth)

**32676** (NP-10840) STENOGRAMMA 16-I LEKTSII PO TEORII SLABYKH VZAIMODEISTVII. (Stenographic Record, 16th Lecture on the Theory of Weak Interactions). L. B. Okun (Akademiya Nauk S.S.S.R. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1961. 11p.

The properties of  $K^0$  mesons of the  $K_1-K_2$  complex are analyzed. The  $K^0$  decay into  $\pi$  mesons changes  $K^0$  and  $\bar{K}^0$  into  $K_1^0$  and  $K_2^0$  with a definite CP parity. The combined parity of  $K_1^0$  is equal to +1 and of  $K_2^0$ , -1. The  $K^0$  and  $\bar{K}^0$  do not have combined parity and  $K_1^0$  and  $K_2^0$  do not have a determined strangeness value. This is caused by a combined inversion transformation in which the strangeness changes sign. A particle with a nonneutral strangeness value at CP-inversion into an antiparticle cannot have a definite combined parity value. (R.V.J.)

**32677** (NP-10841) POLYARIZATSIYA NEITRONOV V REAKTSII T(d,n)He<sup>4</sup>. (Polarization of Neutrons in the T(d,n)He<sup>4</sup> Reaction). I. S. Strostin, V. A. Smotryaev, and I. I. Levintov (Akademiya Nauk S.S.S.R. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1961. 7p.

The azimuthal asymmetry in T(d,n)He<sup>4</sup> ( $E_d = 9.9 \pm 0.7$  Mev) was measured as a function of the neutron emission angle  $Q_n$ . A considerable asymmetry was found at  $Q_n = 70^\circ$  (lab. system). The azimuthal symmetry at the above angle of emission was measured in relation to the angle of scattering on He<sup>4</sup>. The results are correlated according to Seagrave scattering phases  $n-He^4$  and Gammel-Taller



p-He<sup>4</sup> phases. Evaluations of neutron polarization in T(d,n)He<sup>4</sup> according to Gammel-Taller phases results in  $P_T(70^\circ) = (+32.1 \pm 3.0)\%$  (positive direction of the normal  $\vec{K}_n \times \vec{K}_d$ ). (tr-auth)

**32678** (NP-10842) STENOGRAMMA 14-I LEKTSII PO TEORII SLABYKH VZAIMODEISTVII. (Stenographic Record, 14th Lecture on the Theory of Weak Interactions). L. B. Okun (Akademiya Nauk S.S.S.R. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1961. 14p.

The process of  $\Xi^- \rightarrow \Lambda^0 + \pi$  decay, where the product particles strongly interact, is analyzed. (R.V.J.)

**32679** (NP-10845) STENOGRAMMA 15-I LEKTSII PO TEORII SLABYKH VZAIMODEISTVII. (Stenographic Record, 15th Lecture on the Theory of Weak Interactions). L. B. Okun (Akademiya Nauk S.S.S.R. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1961. 16p.

The weak interactions  $(\bar{\lambda}p)(\bar{p}n) + (\bar{p}\lambda)(\bar{n}p)$  resulting in non-leptonic decays violate isotopic spin conservation and the law of conservation of strangeness. This violation is a result of strong selection rules, which determine isotopic spin (T) changes, their third projection (T<sub>3</sub>), and, consequently, the strangeness (S). (R.V.J.)

**32680** (NP-10846) K TEORII VEKTONA. (The Vector Theory). I. Yu. Kobzarev and L. B. Okun (Akademiya Nauk S.S.S.R. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1961. 14p. (ITEP-61-10).

An analysis is made of vector theory. The vector nuclear charge, contribution to the nucleon electromagnetic form-factor, and the feasibility of experimental observations are discussed. (R.V.J.)

**32681** (ORNL-3091) DIFFUSION OF SLOW ELECTRONS IN GASES (thesis). D. W. Forester and L. W. Cochran (Oak Ridge National Lab., Tenn.). Oct. 24, 1961. Contract W-7405-eng-26. 115p.

Submitted to Univ. of Tennessee, Knoxville.

The properties of electrons in a gas and an external electric field, e.g., agitation velocity, free path, energy lost per collision, and collision cross sections, were determined for electrons of energy less than 2 eV in a large number of gases. The computations were made from previously measured values for Townsend's energy factor or the ratio of electron agitation energy to molecule thermal energy. Results are presented for hydrogen, nitrogen, carbon dioxide, methane, ethylene, cyclopropane, and argon. (D.L.C.)

**32682** APPLICATION OF A NON-LOCAL FACTORABLE POTENTIAL TO THE THREE-BODY PROBLEM IN NUCLEAR THEORY. B. B. Dotsenko (Inst. of Physics, Academy of Sciences, Ukrainian SSR). Dopovidi Akad. Nauk Ukr. R.S.R., No. 4, 473-7(1961). (In Ukrainian)

It is shown that when a non-local but factorable potential is used in the three-nucleon problem, it is comparatively simple to obtain basic formulas and equations both for the scattering and for the bound state of the three nucleons. The factorization of the potential corresponds to the development over the states with fixed angular moments. The resulting equations can be solved when the potential is expressed in a concrete form, both by numerical and by approximate analytical methods. (auth)

**32683** TO THE QUESTION OF ELECTRON ANGULAR DISTRIBUTION AT  $\mu$ -MESON DECAY. M. Friml and A. Mazur (Faculty of Technical and Nuclear Physics, Prague). Czechoslov. J. Phys., 11B: 554-8(1961). (In English)

Measurement of the angular distribution of electrons at the decay of  $\mu$  mesons in a longitudinal magnetic field is

described. The results of measurement indicate that electrons are emitted with preference not only in the direction parallel to the spin orientation of  $\mu$  meson but also in the antiparallel direction in disagreement with the angular distribution predicted by theory. (auth)

**32684** SCATTERING OF ELECTRONS BY A SCREENED COULOMB FIELD IN HIGHER BORN APPROXIMATION. T. K. Mitra (Indian Assn. for the Cultivation of Science, Jadavpur, Calcutta). Indian J. Phys., 35: 278-81(June 1961).

The relativistic scattering of electrons by heavy atoms was studied by taking the Rozenal approximation of the Thomas-Fermi potential. The differential cross section of scattering was calculated in the Born approximation up to second order in the expansion of  $(Ze^2/\hbar v)$ . The numerical results of the scattering of electrons of energy 150 keV at an angle  $90^\circ$  were given for the elements, argon, krypton, xenon, and mercury. (auth)

**32685** ON THE  $K^+ + n \rightarrow K^0 + p$  SCATTERING AMPLITUDE POLES. V. Amar and M. Pauri (Università, Milan and Istituto Nazionale di Fisica Nucleare, Milan). Nuclear Phys., 27: 52-7(1961). (In English)

The process  $K^+ + n \rightarrow K^0 + p$  is considered. The effects on this process of the introduction of the interaction  $H' = 2fm_K[K^+K_n^+ + K^0K_n^+]$  proposed by Pais are examined by means of dispersion relations at fixed energy. A useful formula for the estimation of  $f_R$  is obtained by standard methods. A concrete possibility of discriminating between the models of Pais and of Gell-Mann is investigated. Finally, some consequences for isobaric conservation rules in the K-baryon interactions are discussed in connection with the possible existence of a vertex like  $\bar{K}K\pi$ , whether elementary or not. (auth)

**32686** INTERPRETATION OF ISOBARIC MULTIPLETS IN TERMS OF THE SPACE-TIME REFLECTION GROUP. H. Sokolik (Magnetic Lab., Academy of Sciences, Moscow). Nuclear Phys., 27: 94-102(1961). (In English)

A mathematical interpretation of Goldansky's scheme is presented. The number of spinor and scalar representations of the general Lorentz group is shown to be equal to the total number of mesons and baryons of the Gell-Mann scheme. (auth)

**32687** SCATTERING OF  $\pi$ -MESONS ON K-MESONS AT LOW ENERGIES. P. S. Isaev and M. V. Sewerynski (Joint Inst. for Nuclear Research, Dubna, USSR). Nuclear Phys., 27: 148-59(1961). (In English)

Explicit expressions for s- and p-phase shifts of  $\pi$ -K scattering are obtained in the effective-range approximation. (auth)

**32688** THE INTERACTIONS OF  $\pi^-$ -MESONS WITH COMPLEX NUCLEI IN THE ENERGY RANGE (100-800) MEV. II. THE INTERACTION LENGTHS AND ELASTIC SCATTERING OF 750 MEV  $\pi^-$ -MESONS IN G5 EMULSION. J. E. Allen, A. J. Apostolakis, Y. J. Lee, J. V. Major, and E. Perez Ferreira (Univ. of Durham, Eng.). Phil. Mag. (8), 6: 833-8(July 1961).

A total of 100.5 m of track was scanned in a block of emulsion exposed to the 750 MeV  $\pi^-$ -meson beam of the Brookhaven cosmotron. Allowing for the beam contamination of 7%, the interaction lengths for the production of inelastic events and for elastic scattering with projected angles of  $2 \leq \phi < 10^\circ$  are  $(43.6 \pm 2.9)$  cm and  $(66.8 \pm 5.6)$  cm respectively. The geometrical interaction length is 29.3 cm. A comparison with the optical model of the nucleus gives a value for the absorption coefficient  $K = (1.5 \pm 0.2) 10^{42} \text{ cm}^{-1}$  and for the change in wave number

$k_1 = (1.84 \pm 0.06) 10^{12} \text{ cm}^{-1}$ . The absorption coefficient corresponds to a mean free path in nuclear matter  $\lambda_n = (6.7 \pm 0.9) 10^{-13} \text{ cm}$ , to an imaginary component of potential  $V_1 = (15 \pm 2) \text{ Mev}$  and with the value of the change in wave number to a real potential  $V_r = (36 \pm 1) \text{ Mev}$ . (auth)

**32689 TOTAL CROSS SECTIONS FOR NEGATIVE PIONS ON PROTONS AT 230, 290, 370, 427, AND 460 Mev.** John C. Carls, Lester K. Goodwin, Robert W. Kenney, Victor Perez-Mendez, and Walton A. Perkins, III (Univ. of California, Berkeley). *Phys. Rev.*, 122: 262-4 (Apr. 1, 1961). (UCRL-9463)

Total cross sections for negative pions on protons were measured at laboratory energies of 230, 290, 370, 427, and 460 Mev. The measurements were made in the same pion beams as and at energies identical with those of our  $\pi^-p$  differential scattering experiments. Comparisons of the total and differential scattering can be made with the dispersion theory at a given energy without introducing the systematic errors that would normally enter due to uncertainties in the parameters of more than one pion beam. The measured total cross sections are found to agree with in statistics with other measured values, and with the sums of elastic, inelastic, and charge-exchange cross sections measured at this laboratory. (auth)

**32690 VAVILOV-CHERENKOV EFFECT AND "BOHR RADIATION" PRODUCED BY A BEAM OF CHARGED PARTICLES IN A DISPERSIVE MEDIUM.** Jacob Neufeld and Harvel Wright (Oak Ridge National Lab., Tenn.). *Phys. Rev.*, 124: 1-16 (Oct. 1, 1961).

An electron beam interacting with a dispersive (atomic or molecular) medium produces two intense sources of instability that are represented by a growing longitudinal wave and a growing transverse wave. The longitudinal wave has frequencies that are equal to the atomic binding frequencies of the surrounding medium and is designated as the "Bohr wave." The transverse wave has frequencies determined by the Vavilov-Cherenkov criterion and is similar to the Vavilov-Cherenkov wave produced by a single particle interacting with the medium. These sources of instability are "continued" into lower frequency ranges in which they produce growing waves of a "hybrid" type that are characterized by an electric vector having both longitudinal and transverse components. The longitudinal and transverse waves represent the "fundamental modes" that exist in the medium in the absence of the beam. The perturbation produced by the beam is responsible for the instability of the fundamental modes and for the occurrence of the coupling between these modes. The coupling produces electromagnetic waves in which the electric field has a longitudinal component. The conditions for coupling and the character of the instabilities are investigated. (auth)

**32691 EFFECTIVE DEPTH OF X-RAY PRODUCTION.** Harold P. Hanson and Semaan I. Salem (Univ. of Texas, Austin). *Phys. Rev.*, 124: 16-21 (Oct. 1, 1961).

By measuring x-ray emission profiles as a function of voltage, the depth of penetration of the cathode electrons involved may be calculated. Similarly, the effective depth of x-ray production may be obtained. Uncertainties exist because of conditions at the surface, so the rate of change of these depths with voltage may be established with greater confidence than the values themselves. For copper, the continuum yields values increasing from 300 A/kv to 480 A/kv over the 10-30 kv range. An average value of 450 A/kv is obtained from analysis of the less trustworthy line data. The effective depth obtained from the conventional

calculation on the absorption edge is shown to have little physical meaning. (auth)

**32692 INDIRECTLY AND DIRECTLY PRODUCED X-RAY LINE RADIATION.** Harold P. Hanson and David J. Cowan (Univ. of Texas, Austin). *Phys. Rev.*, 124: 22-6 (Oct. 1, 1961).

A direct comparison has been made of the number of x-ray quanta in the K line spectrum to the number of quanta in the continuous spectrum having energies greater than the critical value for K excitation. From this, one can deduce that, for a copper target operating at low voltages, only about 10% of the line radiation is indirectly produced. A further result is that the ratio of the cross section for direct ionization to the cross section for bremsstrahlung production is about 4/1, a value which is at least an order of magnitude less than theory predicts. (auth)

**32693 MOMENTUM AND ANGULAR DISTRIBUTION OF RECOIL ELECTRONS IN TRIPLET PRODUCTION.** R. C. Mohanty, E. H. Webb, H. S. Sandhu, and R. R. Roy (Pennsylvania State Univ., University Park). *Phys. Rev.*, 124: 202-5 (Oct. 1, 1961).

Ilford G-5 emulsion was bombarded by a hardened bremsstrahlung spectrum of maximum energy 90 Mev. In 54 433 fields of view of the microscopes 1935 triplets were observed, out of which 1872 triplets were measured in the energy interval of 2 to 90 Mev. Recoil momentum distributions of the low-energy partner of the triplets have been compared with the theory of Suh and Bethe. In addition, the angular distribution of recoil electrons has been presented. (auth)

**32694 DYNAMICAL MODEL OF ELEMENTARY PARTICLES BASED ON AN ANALOGY WITH SUPERCONDUCTIVITY. [PART] II.** Y. Nambu and G. Jona-Lasinio (Univ. of Chicago). *Phys. Rev.*, 124: 246-54 (Oct. 1, 1961).

Continuing the program developed in a previous paper, a "superconductive" solution describing the proton-neutron doublet is obtained from a nonlinear spinor field Lagrangian. The pions of finite mass are found as nucleon-antinucleon bound states by introducing a small bare mass into the Lagrangian which otherwise possesses a certain type of the  $\gamma_5$  invariance. In addition, heavier mesons and two-nucleon bound states are obtained in the same approximation. On the basis of numerical mass relations, it is suggested that the bare nucleon field is similar to the electron-neutrino field, and further speculations are made concerning the complete description of the baryons and leptons. (auth)

**32695 RADIATIVE DECAY OF THE NEUTRAL K MESON:  $K^0 \rightarrow \gamma + \gamma$ .** J. Dreitlein and H. Primakoff (Univ. of Pennsylvania, Philadelphia). *Phys. Rev.*, 124: 268-73 (Oct. 1, 1961).

The consequences of the particle mixture theory of the neutral K meson are investigated for the rare radiative decay mode:  $K^0 \rightarrow \gamma + \gamma$ . The two photon decay rates of the  $K_1^0$ ,  $K_2^0$  mesons are estimated as  $\approx 1.3 \times 10^5 \text{ sec}^{-1}$  (Cabibbo and Ferrari) and  $\approx \{1.6 \times 10^5 / (g^2 \Sigma K^2 / 4\pi)\} \text{ sec}^{-1} \approx 10^5 \text{ sec}^{-1}$ . It is shown that a time-dependent net circular polarization of each of the two photons results from the interference between the  $K_1^0$  and  $K_2^0$  channels feeding the  $2\gamma$  state. The correlated linear polarizations of the two photons also exhibit a similar time-dependent behavior. The possibility of experimental detection of the effects discussed, from which the sign as well as the magnitude of the  $K_1^0$ ,  $K_2^0$  mass difference can be determined, is very briefly explored. (auth)



**32696**  $K_1^0-K_2^0$  MASS DIFFERENCE. V. Barger and E. Kazes (Pennsylvania State Univ., University Park). Phys. Rev., 124: 279-80 (Oct. 1, 1961).

To account for the  $K_1^0-K_2^0$  mass difference a direct  $K_1^0-2\pi$  interaction is introduced which gives  $\tau(K_1^0)[m(K_1^0)-m(K_2^0)]$  in terms of the  $I=0$ , s-wave pion-pion scattering phase shifts. (auth)

**32697** POLARIZATION IN NEUTRON-PROTON SCATTERING BELOW 100 Mev. P. H. Bowen, G. C. Cox, G. B. Huxtable, A. Langsford, J. P. Scanlon, and J. J. Thresher (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phys. Rev. Letters, 7: 248-50 (Sept. 15, 1961).

Polarized neutron beams of energy (E) interact with protons, and two axially symmetrically placed counters (at angle  $\theta$  with the neutron beam) are used to measure the n-p polarization. The polarization is measured at several values of E between 22.5 and 90 Mev and  $\theta$  between 20 and 80°. (T.F.H.)

**32698** PHOTODISINTEGRATION OF POLARIZED AND ALIGNED DEUTERONS. W. Zickendraht, D. J. Andrews, and M. L. Rustgi (Yale Univ., New Haven). Phys. Rev. Letters, 7: 252-5 (Sept. 15, 1961).

The reaction  $d(\gamma, n)p$  is studied for  $\gamma$  energies of 20 to 180 Mev, using unpolarized  $\gamma$  rays and polarized and aligned deuterons. The differential proton production cross section is calculated as a function of  $\gamma$  energy, scattering angle, and relative ( $\gamma$ -beam)-(polarization axis)-(alignment axis) orientations. (T.F.H.)

**32699**  $K_2^0$  DECAYS AND INTERACTIONS. D. Luers, I. S. Mittra, W. J. Willis, and S. S. Yamamoto (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 7: 255-9 (Sept. 15, 1961). (BNL-5567)

The charged-particle decays of  $K_2^0$  mesons,  $K_2^0 \rightarrow \pi^+ + e^- + \nu(\pi e \nu)$ ,  $K_2^0 \rightarrow \pi^+ + \mu^- + \nu(\pi \mu \nu)$ , and  $K_2^0 \rightarrow \pi^+ + \pi^+ + \pi^0$  ( $\pi\pi\pi$ ) are studied. Several conclusions are drawn: the ratio  $\pi^+e^- + \nu/\pi^+\mu^- + \nu = 1.16 \pm 0.17$ ; the  $\pi e \nu$  decay is a pure vector interaction in agreement with V-A theory; and an intermediate boson with mass  $>500$  Mev/ $c^2$  may exist. The branching ratios for these types of decays are determined and predictions are compared with  $\Delta I = 1/2$  and  $\Delta I = 3/2$  current rules. The interactions  $K_2^0 + p \rightarrow K_1^0 + p$ ,  $K_2^0 + p \rightarrow \Lambda^0 + \pi^+$ , and  $K_2^0 + p \rightarrow \Sigma^0 + \pi^+$  are also studied. (T.F.H.)

**32700** METHOD FOR DETERMINING THE SPIN OF THE  $K-\pi$  RESONANCE. David O. Caldwell (CERN, Geneva). Phys. Rev. Letters, 7: 259-61 (Sept. 15, 1961).

It is proposed that the spin of the  $K-\pi$  resonance  $K^*$  be determined by analysis of the  $K^*$  production reactions  $K + He^4 \rightarrow K^* + He^4$  and  $K + He^4 \rightarrow K^* + He^4 + \pi$ . The angular distributions of the  $K^*$  and its decay products yield information as to the  $K^*$  spin and the  $K^*K$  relative parity. (T.F.H.)

**32701** HELICITY OF THE PROTON FROM  $\Lambda$  DECAY. J. Leitner (Syracuse Univ., N. Y.), L. Gray, E. Harth, et al. Phys. Rev. Letters, 7: 264-8 (Sept. 15, 1961).

The helicity of the proton from  $\Lambda$  decay (i.e., the sign of the proton polarization, in the decay rest frame) is measured. The proton polarization is given by  $\vec{\sigma} = -\alpha \vec{k}/|\vec{k}|$ , where  $\alpha$  is the decay asymmetry parameter and  $\vec{k}$  is the c. m. momentum of the proton. Calculations yield  $\alpha = -0.75^{+0.50}_{-0.15}$ , so that  $\vec{\sigma}$  must be positive. (T.F.H.)

**32702** LEWIS EFFECT IN RESONANCE YIELD CURVES. W. L. Walters, D. G. Costello, J. G. Skofronick, D. W. Palmer, W. E. Kane, and R. G. Herb (Univ. of Wisconsin, Madison). Phys. Rev. Letters, 7: 284-5 (Oct. 1, 1961).

Gamma-ray yield spectra from the reaction  $Al^{27}(p, \gamma)Si^{28}$

are measured near the 992-keV resonance. The  $\gamma$  yield has a maximum just above the resonance energy, followed by a shallow minimum; the yield at higher energies levels out to a constant value. The maximum and minimum in the  $\gamma$  yield are contained in an energy region from about 0 to 2 keV above the resonance energy. (T.F.H.)

**32703** ASYMMETRY PARAMETERS IN THE DECAYS  $\Sigma^+ \rightarrow p + \pi^0$  AND  $\Lambda \rightarrow p + \pi^-$ . E. F. Beall, Bruce Cork, D. Keefe, P. G. Murphy, and W. A. Wenzel (Univ. of California, Berkeley). Phys. Rev. Letters, 7: 285-8 (Oct. 1, 1961). (UCRL-9820)

By analysis of the decay proton polarization, the asymmetry parameters  $\alpha_0$  and  $\alpha_\Lambda$  for the decay reactions  $\Sigma^+ \rightarrow p + \pi^0$  and  $\Lambda \rightarrow p + \pi^-$ , respectively, are measured. It is found that  $\alpha_0 = +0.75 \pm 0.17$ . Assuming, conservatively, that  $|\alpha_\Lambda| > 0.6$ , the data indicate that  $\alpha_\Lambda$  is negative with a confidence of at least 25:1. Thus,  $\alpha_0 = -\alpha_\Lambda$ . (T.F.H.)

**32704** PERIPHERAL COLLISIONS AND THE  $(\frac{3}{2} \frac{3}{2})$  RESONANCE IN THE REACTION  $p + p \rightarrow n + p + \pi^+$  AT 970 MEV. V. E. Barnes (Cavendish Lab., Cambridge, Eng.), D. V. Bugg, W. P. Dodd, J. B. Kinson, and L. Riddiford. Phys. Rev. Letters, 7: 288-90 (Oct. 1, 1961).

A model for the  $p + p \rightarrow n + p + \pi^+$  reaction at 970 Mev is considered, in which the neutron acts as "spectator" and the proton and pion interact in a  $T = \frac{3}{2}$  state. Peripheral collisions, in which one nucleon interacts with a virtual pion in the field of the other nucleon, have a large cross section in this model. For 1170 observed events, the  $p-\pi^+$  Q-values and differential cross sections are found as functions of the neutron energy and compared with the model's predictions. The results are used to investigate the  $p-\pi^+$  scattering cross sections. (T.F.H.)

**32705** REMARK ON THE ALGEBRA OF INTERACTIONS. A. Pais (CERN, Geneva). Phys. Rev. Letters, 7: 291-3 (Oct. 1, 1961).

The theory of the structure of elementary particle interactions is examined, using a formalism involving octonions. The relations between quaternions and octonions, as well as the algebraic properties of octonions, are discussed. The relations between octonion transformations and elementary particle interactions are shown. The formalism is described for strong, non-leptonic weak, and leptonic weak interactions. (T.F.H.)

**32706** THE DETERMINATION OF  $m/e$  FOR FREE ELECTRONS BY MOMENTUM TRANSFER. H. A. Daw and F. S. Harris, Jr. (Univ. of Utah, Salt Lake City). Proc. Phys. Soc. (London), 78: 433-7 (Sept. 1, 1961).

A new method for measuring  $m/e$  for free electrons was developed by using momentum transfer. A Faraday cage mounted on a torsion device collects electrons from an electron gun. The change in maximum angular displacement of the fibre with electron beam on and off, together with the measured current, gave a value of  $m/e$  of  $5.82 \times 10^{-12}$  kg/C compared to the accepted value of  $5.6854 \times 10^{-12}$  kg/C. (auth)

## Neutron Physics

**32707** (BAW-1203(Vol.IV)) NUCLEAR MERCHANT SHIP REACTOR PROJECT; EXTENDED ZERO POWER TESTS: NS SAVANNAH, CORE I. Final Report. R. M. Ball, C. E. Barksdale, M. L. Batch, J. W. Cure, J. P. Farrar, R. N. Kubik, R. H. Lewis, A. L. MacKinney, J. H. Mortenson, T. G. Pitts, S. W. Spetz, and H. J. Worsham (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). July 1960. Contract AT(30-1)-2534. 404p.

Included are IBM-704 computer printouts for two three-dimensional neutron-diffusion code cases corresponding to experimental runs from the NMSR zero power tests. A complete definition of each type of output is presented and its application to the problem is outlined. (B.O.G.)

**32708** INVARIANT IMBEDDING AND VARIATIONAL PRINCIPLES IN TRANSPORT THEORY. Richard Bellman (RAND Corp., Santa Monica, Calif.), Robert Kalaba, and G. Milton Wing. *Bull. Am. Math. Soc.*, 67: No. 4, 396-9 (July 1961). (SCR-402)

A single variational problem is derived which yields the linear equations of conventional transport theory when treated by means of the calculus of variations, and which yields the nonlinear equations of invariant imbedding when approached by means of the functional equation techniques of dynamic programming. The problem considered is a steady-state transport process, involving absorption, fission and scattering, taking place in a one-dimensional rod. For the sake of simplicity, the rod is homogeneous and isotropic. At the conceptual level, the results provide a unified approach to the treatment of internal and external fluxes along classical and modern lines. At the analytic and computational levels, the results enable the calculation of various inequalities for the reflected fluxes and the application of the Rayleigh-Ritz techniques to the determination of fluxes and critical lengths. (N.W.R.)

## Nuclear Properties and Reactions

**32709** (AFOSR-398) THEORETICAL INTERPRETATION OF CARBON-13 HYPERFINE INTERACTIONS IN ELECTRON SPIN RESONANCE SPECTRA. Technical Note Report No. 9. Martin Karplus (Watson Scientific Computing Lab., New York; Columbia Univ., New York) and George K. Fraenkel (Columbia Univ., New York). May 1, 1961. Contract AF49(638)-520. 45p. (CU-9-61-AF-520-Chem.; AD-255802)

A quantitative theory of the isotropic electron-nuclear spin interactions of  $C^{13}$  in pi-electron radicals is presented and applied to the hyperfine splittings observed in the electron spin resonance spectra of these substances. The splittings arise from sigma-pi interactions which polarize both the 1s and 2s electrons. The 1s-orbital spin polarization is shown to contribute a term of negative sign with a magnitude comparable to that from the 2s electrons. For an  $sp^2$  hybridized carbon atom that is bonded to three atoms,  $X_i$  ( $i = 1, 2, 3$ ), the hyperfine constant  $a^C$  has the form  $a^C = (S^C + \sum_{i=1}^3 Q_{CX_i}^C) p^\pi + \sum_{i=1}^3 Q_{X_iC}^C p_i^\pi$  where  $p^\pi$  and  $p_i^\pi$  ( $i = 1, 2, 3$ ) are the pi-electron spin densities on atoms C and  $X_i$ , respectively. The contribution of the 1s electrons is determined by  $S^C$  and that of the 2s electrons by the  $Q$ 's, where  $Q_{BC}^A$  is the sigma-pi parameter for the nucleus of atom A resulting from the interaction between the bond BC and the pi-electron spin density on atom B. Calculations for a planar  $CHC_2$  fragment model yield  $S^C = -12.7$  gauss,  $Q_{CH}^C = 19.5$  gauss,  $Q_{CC'}^C = 14.4$  gauss, and  $Q_{C/C}^C = -13.9$  gauss. The theory predicts both the magnitude and sign of the hyperfine splittings and is readily applied to a variety of compounds. Excellent agreement is obtained with the available experimental data. For the methyl radical, the measured  $C^{13}$  splitting is shown to be consistent with a planar model and limits the deviation from planarity to  $\geq 5^\circ$ . The theory provides a useful criterion for the validity of approximate wave functions and is illustrated by a comparison of various theoretical treatments for the naphthalene negative ion and triphenylmethyl. The sigma-pi interaction parameters are shown to depend on the bond length,

the type of hybridization (including the angles between sigma bonds), and on the nature of the bonding atoms. For pi-electron systems, the results demonstrate that the magnitude of the sigma-pi exchange energy is a small fraction of the total energy. It is also noted that the proton parameter  $Q_{CH}^H$  is somewhat larger in  $CHC_2$  than in  $CH_3$ , which suggests a theoretical justification for some of the variation in the experimental " $Q_{CH}^H$ " required to fit measured proton splittings. The form of the theory is readily extended to the treatment of hyperfine splittings from nuclei other than  $C^{13}$ . (auth)

**32710** (APEX-613) PROTON CROSS SECTIONS. Mary S. Ferry (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Mar. 15, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 103p.

A listing is presented of a comprehensive compilation of photon energy deposition, isotropic energy transfer, and anisotropic energy transfer cross sections for ninety-four elements, processed for use with eleven-energy transport and diffusion analyses of core, reflector, and control-rod heating in high-performance fission reactors. (auth)

**32711** (APEX-628) GAMMA RAY ABSORPTION COEFFICIENTS FOR ELEMENTS AND MIXTURES. M. A. Capo (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Aug. 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 28p.

Mass gamma ray total and energy absorption coefficients are tabulated as a function of energy from 0.2 to 10 Mev for various elements, mixtures, and compounds. The data presented here are based on the latest published results of Dr. G. White Grodstein, National Bureau of Standards. Polynomial expressions are given for approximation of absorption coefficients for elements or energy levels not tabulated by Dr. Grodstein. (auth)

**32712** (APEX-633) EVALUATION OF BERYLLIUM AND URANIUM CROSS SECTIONS FOR NEUTRON DIFFUSION THEORY CALCULATIONS. F. G. Dawson (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Oct. 1958. Contracts AF33(600)-38062 and AT(11-1)-171. 38p.

The results of reactor physics analyses of critical experiments performed on beryllium- or beryllium-oxide-moderated, highly enriched uranium-fueled assemblies. Reactivity calculations based upon sets of beryllium cross sections with various allowances for the  $Be(n,2n)$  reaction as well as two sets of  $U^{235}$  cross sections were compared with the experimental data. It is found that the  $Be(n,2n)$  interaction has a large effect on the multiplication constant. On the basis of this study, a set of beryllium cross sections with a representation of the  $(n,2n)$  and  $(n,\alpha)$  reactions, and a set of  $U^{235}$  cross sections were selected for calculating the multiplication constant of beryllium- and beryllium-oxide-moderated reactors. The cross section "recipe" when used with GE-ANPD diffusion theory codes produced analytical results within  $\pm 1\%$  of the experimental multiplication constant for BeO systems having a thermal fission fraction (fraction of all fissions that are produced by thermal neutrons) ranging from 5 to 51%. (auth)

**32713** (APEX-645) MULTIGROUP NUCLEAR DATA FOR GE-ANPD COMPUTER PROGRAM-S. R. L. Dough (ASTRA, Inc., Raleigh, N. C.). Feb. 1961. For General Electric Co. Flight Propulsion Lab. Dept., Cincinnati. Contracts AF33(600)-38062 and AT(11-1)-171. 133p.

Neutron and photon data for twenty-five elements were compiled for use in the multigroup transport theory IBM-704 program, GE-ANPD Program S. The neutron data are tabulated in twenty-four groups (18 Mev-thermal) and the photon data in twelve groups (0.064-10.2 Mev). (auth)



**32714** (APEX-653) HAND CALCULATION OF SPATIAL DISTRIBUTION OF NEUTRON ACTIVATION. J. T. Lence, H. R. Kroeger, Andrew Lowery, F. A. Bryan, Jr., and E. M. Page (ASTRA, Inc., Raleigh, N. C.). Aug. 1960. For General Electric Co. Flight Propulsion Lab. Dept., Cincinnati. Contracts AF33(600)-38062 and AT(11-1)-171. 34p.

Methods were developed which would make it possible to calculate, by hand, foil activation distributions in various shielding materials. Foils used were sulfur and bare and cadmium-covered copper. BeO, LiH, and stainless steel were used in the shielding configurations. Graphs are included showing experimental and calculated results. (M.C.G.)

**32715** (APEX-709) TWENTY-FIVE GROUP REACTOR NUCLEAR DATA TAPE NEUTRON CROSS SECTIONS. J. W. Zwick and T. J. Kostigen (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). June 13, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 378p.

A compilation is presented, in the twenty-five group Reactor Nuclear Data Tape format, of neutron cross sections for elements of major interest for GE-ANPD reactor analysis. The tabulated data are a reproduction of neutron cross section information contained on the Reactor Nuclear Data Tape, which was recently prepared. A brief outline of methods used in processing of the cross sections is also included. (auth)

**32716** (AROD-1607.10) COMPARATIVE STUDY OF EMPIRICAL INTERNUCLEAR POTENTIAL FUNCTIONS. Derek Steele, Ellis R. Lippincott (Maryland. Univ., College Park) and Joseph T. Vanderslice (Maryland. Univ., College Park. Inst. of Molecular Physics). July 1961. 62p.

A comparative study of empirical internuclear potential functions was carried out using the criterion that a function should reproduce the experimental potential curves as determined by the Rydberg-Klein-Rees method. An additional criterion used was that a function should predict acceptable relations between the spectroscopic constants, namely, the dissociation energy,  $D_e$ , the vibrational frequency,  $\omega_e$ , the equilibrium bond length,  $r_e$ , the anharmonicity  $w_{ex}$ , and the vibrational rotational coupling constant,  $\alpha_e$ . The empirical functions considered were the Hulbert-Hirschfelder, Linnett, Morse, Rosen-Morse, Poschl-Teller, Frost-Musulin, Rydberg, Varshni, and Lippincott. The better functions were capable of reproducing the Rydberg-Klein-Rees experimental curves to an average error of 2 to 3% in bond dissociation energy. For  $r > r_e$ , the corresponding average error was in the range of 1 to 2%. Functions which give acceptable agreement with the Rydberg-Klein-Rees curves usually give acceptable relations among the spectroscopic constants but notable exceptions were found with the Hulbert-Hirschfelder and Varshni functions. The Linnett and Hulbert-Hirschfelder functions had the disadvantage that they sometimes predict spurious maxima for states where none are known or expected to exist. The relative performance of the respective functions was in increasing order as listed. Indications were that no substantial improvement (errors of less than 1% in  $D_e$ ) can be made in predicting potential curves by proposing other empirical curves which have no theoretical or experimental foundations. The results further indicated that for  $r \gg r_e$  relatively large errors can be made in predicting interaction energies from empirical functions. (auth)

**32717** (JINR-P-288) VOZBUZHDENNYE SOSTOYANIYA DEFORMIROVANNYKH YADER. (Excited States of Deformed Nuclei). B. S. Dzhelepov and L. K. Peker (Joint

Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1959. 28p.

Previously reported data on the properties and excited states of deformed nuclei ranging from Nd to Os are supplemented by new information derived from re-examined decay schemes. Rotational levels were separated and single-particle levels were interpreted within the Nilsen diagram limits. A collective study of all deformed even nuclei indicates the presence of more or less developed rotation bands in each non-rotational level at excitation energies up to 2 Mev. Correlation of the energy intervals between mono-type single particle levels in nuclei with identical numbers of nucleons shows variations according to the Nilsen diagram. In the initial region where an addition of a nucleon pair increases the nuclear deformation, the distance between levels increases as the number of pairs increases. As the end of the region is approached, the addition of each nucleon pair reduces the interval in accordance with reduced deformation. (R.V.J.)

**32718** (KAPL-M-JA-11) A STUDY OF THE KAPL FORMULATION OF THE EQUATIONS DESCRIBING THE BURNUP OF  $U^{235}$  AND  $B^{10}$ . J. A. Archibald, Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). Aug. 1, 1961. Contract W-31-109-Eng-52. 31p.

The equations describing the burnup or depletion of  $U^{235}$  and  $B^{10}$  in use at KAPL are presented, together with a sketch of their derivation. Generalizations and proposed modifications are also included. (auth)

**32719** (NBS-TN-71) CALIBRATION OF FIVE GAMMA-EMITTING NUCLIDES FOR EMISSION RATE. J. M. R. Hutchinson (National Bureau of Standards, Washington, D. C.). Aug. 1960. 25p. (PB-161572).

$Hg^{203}$  and  $Nb^{95}$  were calibrated by a  $4\pi\beta\text{-}\gamma$  coincidence method for  $\gamma$ -emission rate,  $Zn^{65}$  by comparison with the 1.12-Mev peak of  $Sc^{46}$ ,  $Na^{22}$  by a  $\gamma$ -annihilation-quanta coincidence method and by a triple coincidence method, and  $Sr^{85}$  by x- $\gamma$  coincidence counting. The accuracy of the calibration in all cases was  $\pm 2\%$ . The half life of the isomeric state of  $Rb^{85}$  was measured and found to be 0.98 microseconds. (auth)

**32720** (NP-10829) THE MOSSBAUER EFFECT IN IRON-57. Technical Report No. 28. Seymour Margulies (Illinois. Univ., Urbana). Oct. 1961. Contract ONR 1834 (05). 116p.

An attempt was made to detect the Mössbauer effect in  $Fe^{57}$ . The phenomena of resonance fluorescence and recoilless gamma emission and absorption were studied. The intensity of the 14.4-keV radiation from the first excited state of  $Fe^{57}$  passing through a resonance absorber which was moved with respect to the source was measured. When the  $Fe^{57}$  nuclei were imbedded in a ferromagnetic material, the interaction of the nuclear magnetic moments of the ground and first excited states with the effective magnetic field at the nuclei positions split the 14.4-keV transition into 6 Zeeman components. Polarization phenomena which accompany the Zeeman effect were observed. Assuming Lorentzian emission and absorption spectra, an integral expressing the transmission of resonance radiation from a source of finite thickness through a resonance absorber is presented. It was found that the transmitted line is approximately a Lorentz curve whose width increases with increasing source and absorber thickness. The characteristics of the transmitted line were found to be strongly dependent on spectral shape. (M.C.G.)

**32721** (NP-10838) K DISPERSIONNOI TEORII PRYAMYKH YADERNYKH REAKTSII. (Dispersion Theory of Direct Nuclear Reactions). I. S. Shapiro (Akademiya Nauk

S.S.S.R. Institut Teoreticheskoy i Eksperimental'noy Fiziki). 1961. 26p. (ITEP-61-12)

It is postulated that the direct nuclear process amplitude is well described by Feynman diagrams with small numbers of intrinsic lines. A singular integral equation for evaluating the initial and final interaction states was derived by means of dispersion relations. The equation is utilized in a precise solution and simple iteration procedure, and the first iteration suggests the method of wave distortions. It is shown that in addition to the pole diagrams describing the Butler mechanism, stripping reactions, and heavy pickup, a more complex diagram can effectively contribute to the direct process mechanism. This is exhibited in  $\text{Be}^9(d,n)\text{B}^{10}$ ,  $\text{Be}^9(\alpha,t)\text{B}^{10}$ , and  $\text{C}^{12}(d,p)\text{C}^{13}$  reactions and by an analysis of certain reactions of the  $(x,yz)$  type, especially "cluster knock-out" reactions. (tr-auth)

**32722** (NP-10844) POLYARIZATSIYA NEITRONOV V REAKTSII  $^{12}\text{C}(d,n)\text{N}^{13}$ . (Neutron Polarization in the Reaction  $\text{C}^{12}(d,n)\text{N}^{13}$ ). I. I. Levintov and I. S. Trostin (Akademiya Nauk S.S.S.R. Institut Teoreticheskoy i Eksperimental'noy Fiziki). 1961. 6p. (ITEP-61-8)

The azimuthal asymmetry of neutron scattering corresponding to  $\text{N}^{13}$  transition to the ground state was measured with a helium analyzer. The deuteron energy was  $12.3 \pm 0.4$  Mev; the graphite target thickness was 0.9 Mev. Neutron polarization magnitudes for carbon targets at various emission angles were found on the basis of the Seagrave phase for  $n-\alpha$  scattering. The positive direction of the normal is  $\vec{K}_n \times \vec{K}_d$ . (tr-auth)

**32723** (NYO-9749) THE QUANTUM MECHANICAL SCATTERING PROBLEM. II. MULTI-CHANNEL SCATTERING. Thomas F. Jordan (Rochester, N. Y. Univ.). [nd]. Contract AT(30-1)-875. 27p.

The study of the single channel scattering problem was extended to include the multi-channel case. The scattering problem was formulated in a mathematically rigorous way which reflects the time-independent point of view but is not limited by any dependence on a configuration space representation. Wave operators were defined by an integral representation. When the conditions necessary for the time-dependent formulation are valid these wave operators will be identical to those defined by the asymptotic limits and will provide a solution of the scattering problem. But these conditions are stronger than those which are sufficient for a solution, so there should exist a class of Hamiltonian operators for which a solution of the scattering problem exists but for which the asymptotic conditions are not valid. (auth)

**32724** (ORO-472) IONIZATION AND CHARGE TRANSFER CROSS SECTIONS. PHASE III: FAST  $\text{He}^+$  IONS INCIDENT ON He, Ne, Ar,  $\text{H}_2$ ,  $\text{N}_2$ ,  $\text{O}_2$ , AND CO. Technical Status Report No. 8, June 1, 1961 to August 31, 1961. E. W. McDaniel, D. W. Martin, J. W. Hooper, D. S. Harmer, and R. A. Langley (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Sept. 1, 1961. Contract AT(40-1)-2591. 8p.

Data were collected on the ionization of hydrogen by helium ions. A study was made to determine if any of the  $\text{He}^+$  beam entering the collision chamber might contain appreciable numbers of He atoms or  $\text{He}^{2+}$  ions. An accidental loss of power to one of the fore-pumps in the system caused a general failure of the whole vacuum system. During dismantling and cleaning of the equipment, some of it was moved and improvements in support structure made. (M.C.G.)

**32725** (TID-13904) THEORETICAL STUDIES IN NUCLEAR AND HIGH ENERGY PHYSICS. Final Report,

June 1, 1960 to September 30, 1961. Report 1111-Final. Bernard Margolis (Ohio State Univ. Research Foundation, Columbus). Sept. 29, 1961. Contract AT(11-1)-911. 50p.

Three papers are presented on various topics in nuclear and high-energy physics. Separate abstracts were prepared for each of the papers. (D.L.C.)

**32726** (TID-13904(p.4-14)) THE S-WAVE AND P-WAVE STRENGTH FUNCTIONS. T. K. Krueger (Wright Air Development Center. Aeronautical Research Lab., Wright-Patterson AFB, Ohio) and [Bernard] Margolis (Ohio State Univ. Research Foundation, Columbus).

The s-wave and p-wave neutron strength functions, calculated with an optical model, are compared with experiment for spherical nuclei. The real potential is diffuse and has a spin-orbit term. The imaginary potential is surface peaked. This surface peaking produces experimentally required low-strength functions between resonances. A detailed fit to the p-wave strength functions required parameters considerably different from those required to explain other data. (auth)

**32727** (TID-13904(p.15-24)) TWO PHOTON DECAY AND THE LIFETIME OF GIANT RESONANCE STATES. [Bernard] Margolis (Ohio State Univ. Research Foundation, Columbus).

The relative probability for two-photon decay in a low-energy  $0^+ \rightarrow 0^+$  transition is shown to be related to the lifetime of the  $1^-$  states of these nuclei in the giant resonance region. Estimates of this lifetime are made using nuclear reaction theory. Comparison of the resulting two photon decay probability is made with experiment. (auth)

**32728** (TID-13904(p.25-45)) BEHAVIOR OF NUCLEON-NUCLEON SINGLET PHASE SHIFTS. Daniel M. Greemberger and [Bernard] Margolis (Ohio State Univ., Columbus).

By applying a conformal mapping to the partial wave scattering amplitudes, it is possible to confine the entire unphysical branch cut in the amplitude to a compact region. This allows the introduction of a set of expansion functions for approximating the behavior of the amplitude in the physical region. With these functions, the observed energy dependence of the phase shifts can be correlated with that of the imaginary part of the amplitude along the unphysical cut. In this way, it is shown that the  $^1\text{S}_0$  energy dependence seems to require a short range repulsive core. The attractive long-range forces tend to give a positive shape parameter and the hard core a negative one, so the actual sign can go either way. A two parameter  $^1\text{S}_0$  fit up to 300 Mev and, for the  $^1\text{D}_2$  phase shift, a one-parameter fit accurate between 40 and 250 Mev are presented. It is argued that inelastic scattering is small below 250 Mev, and also that a good fit to scattering data up to 250 Mev does not accurately determine the behavior of the amplitude in the unphysical region. (auth)

**32729** (TID-13920) EXCITED STATES IN  $\text{Xe}^{128}$ . R. E. Sund, R. G. Arns, L. I. Yin, and M. L. Wiedenbeck (Michigan Univ., Ann Arbor. Harrison M. Randall Lab. of Physics). [1961]. Contract [AT(11-1)-684]. 7p.

Gamma transitions in  $\text{Xe}^{128}$  following decay of the 25-min  $\text{I}^{128}$  were studied using coincidence techniques. Directional correlation measurements for the 567-kev—439-kev cascade were taken at six angles in each quadrant (every  $15^\circ$  from  $90$  to  $165^\circ$ ), and the corrected expansion coefficients were found to be  $A_2 = -0.180 \pm 0.028$  and  $A_4 = +0.269 \pm 0.047$ . Conversion electrons corresponding to these gamma transitions were observed in a magnetic spectrometer. These measurements confirmed the existence of excited states at 439 kev ( $2^+$ ) and 1006 kev ( $2^+$ ). The spectrograph measure-



ments show tentative evidence for a 0+ excited state at 1016 kev which is de-excited by weak transitions to the first excited state and to the ground state. (auth)

**32730** (TID-13921) NEUTRON-CAPTURE GAMMA RAYS OF NATURAL COPPER. P. A. Treado and P. R. Chagnon ([Michigan Univ., Ann Arbor. Harrison M. Randall Lab. of Physics]). [1961]. Contract [AT (11-1)-684]. 12p.

A sample of natural Cu metal which contains both  $\text{Cu}^{63}$  and  $\text{Cu}^{65}$ , was placed in a reactor-neutron beam and the capture gamma rays were studied by means of a 3-crystal scintillation pair spectrometer and a single scintillation crystal. Gamma rays of 7.94, 7.62, 7.16, 7.01, 6.67, 6.43, 6.02, 5.79, 5.61, 5.28, 5.01, 0.60, 0.28, and 0.095 Mev were found. The present measurements of the ground state gamma rays of 7.92 Mev for  $\text{Cu}^{64}$  and 7.01 Mev for  $\text{Cu}^{66}$  are in good agreement with values measured by other means. Possible level schemes for  $\text{Cu}^{64}$  and  $\text{Cu}^{66}$  are presented. (auth)

**32731** (TID-13922) NEUTRON-CAPTURE GAMMA-RAY SPECTRA OF THE BROMINE ISOTOPES. P. A. Treado and P. R. Chagnon ([Michigan Univ., Ann Arbor. Harrison M. Randall Lab. of Physics]). [1961]. Contract [AT(11-1)-684]. 19p.

Three samples of ammonium bromide were placed in a reactor neutron beam and the emitted capture gamma rays were studied by a single scintillation crystal and a three-crystal scintillation spectrometer. Two of the samples were isotopically enriched, one in  $\text{Br}^{79}$  and the other in  $\text{Br}^{81}$ , while the third was of natural bromine. Most of the natural bromine gamma rays have been assigned to at least one of the two isotopes studied. The intensities of the high-energy gamma rays were measured. The highest-energy gamma ray lines observed with each enriched sample indicate a neutron binding energy of 7.6 Mev for both  $\text{Br}^{80}$  and  $\text{Br}^{82}$ . (auth)

**32732** (TID-13929)  $\beta$ - $\gamma$  ANGULAR CORRELATION IN THE DECAY OF  $\text{Sb}^{124}$ . H. J. Fischbeck and M. L. Wiedenbeck (Michigan Univ., Ann Arbor. Harrison M. Randall Lab. of Physics). [1961]. Contract AT(11-1)-684. 13p.

The directional correlation between the first forbidden non-unique 2.31 Mev  $\beta$  transition and the successive 0.603 Mev  $\gamma$  ray in the decay of  $\text{Sb}^{124}$  were measured at eight  $\beta$ -ray energies. A thin lens spectrometer with a momentum resolution of 7% was used for the analysis of the  $\beta$ -ray energy. The measured angular correlation coefficient  $\epsilon$  ranges from  $-0.28 \pm 0.03$  to  $-0.404 \pm 0.008$  in the energy interval 1.24 to 2.09 Mev. An analysis of the data in the "modified  $B_{1j}$  approximation" is consistent with the experiment and yields two possible values for the matrix element ratio Y. From this, the magnitude of the nuclear matrix elements contributing to the decay can be extracted. (auth)

**32733** (UCRL-9679) CLEBSCH-GORDAN COEFFICIENTS FOR NUCLEAR TRANSITION PROBABILITIES: I. ODD-MASS NUCLIDES. Jacqueline K. Lum, James H. Light, and Frank Asaro (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 25, 1961. Contract W-7405-eng-48. 38p.

Tables are presented for the Clebsch-Gordan coefficients and their squared values for odd-mass nuclides. The values may be used to calculate the alpha, beta, and gamma ray transition probabilities for deformed nuclei. (D.L.C.)

**32734** (UCRL-Trans-723(L)) TO THE DISPERSION THEORY OF X-RAYS. H. Hönl. Translated by S. Shewchuck (California Univ., Livermore. Lawrence Radiation Lab.) from Z. Physik, 84: 1-16 (July 17, 1933). 19p.

The Kallmann-Mark dispersion formula for x rays in the sense of a more accurate consideration of the oscillator distribution at the K-border was improved. The new formula was compared with the dispersion measurements by A. Larsson. In addition, the number of dispersion electrons of the K and L shells was computed for one element. The results were in satisfactory agreement with experience. (auth)

**32735** THE  $T(\alpha, \gamma)\text{Li}^7$  REACTION. G. M. Griffiths, R. A. Morrow, P. J. Riley, and J. B. Warren (Univ. of British Columbia, Vancouver). Can. J. Phys., 39: 1397-1408 (Oct. 1961).

The  $T(\alpha, \gamma)\text{Li}^7$  reaction was observed using thin targets of tritium absorbed in zirconium bombarded by singly charged helium ions at 0.5 to 1.9 Mev. The cross section rises smoothly with energy in a fashion characteristic of a direct radiative capture process. The ratio of the intensities of transitions to the first excited state at 478 kev and to the ground state is  $0.40 \pm 0.05$ . The angular distribution is, to within errors, isotropic at  $E_\alpha = 0.8$  Mev but is significantly higher at  $0^\circ$  than at  $90^\circ$  for  $E_\alpha = 1.6$  Mev. The total capture cross section at a mean alpha-particle energy in the target of 1.32 Mev is  $3.58 \pm 0.60$  microbarns and the corresponding astrophysical S factor is  $0.064 \pm 0.016$  kev barn in the center of mass system. The results are compared with recent theoretical results on the direct radiative capture process. (auth)

**32736** DOUBLE CASCADE TRANSITIONS OF GAMMA RAYS FROM RADIATIVE CAPTURE ON  $\text{Co}^{59}$ . J. Urbanec, J. Kajfosz, and J. Kopecký (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, [Prague]). Czechoslov. J. Phys., 11B: 559-64 (1961). (In English)

Pairs of gamma quanta, giving a sum equal to the binding energy of the last neutron in  $\text{Co}^{60}$  were studied during radiation capture on a  $\text{Co}^{59}$  nucleus. The energies of the gamma quanta giving such cascades were determined and an attempt was made to determine the relative intensities of the different cascades. (auth)

**32737** CONVERSION COEFFICIENT ON K-SHELL OF 88.3 KEV TRANSITION IN  $\text{Hf}^{176}$ . I. Řezanka, J. Frána, and J. Adam (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, [Prague]). Czechoslov. J. Phys., 11B: 611-13 (1961). (In English)

The 88.3-kev transition was excited by the beta disintegration of the isomer of  $\text{Lu}^{176}$  with a half life of 3.7 hr. The 7-day  $\text{Lu}^{177}$  spectrum was subtracted. A 200-channel amplitude analyzer in the 0 to 150 kev was used to measure the gamma spectrum and results are graphically presented and agreed with those obtained using a scintillation technique comparing intensities of characteristic gamma and x radiation. (L.N.N.)

**32738** A GENERAL TREATMENT OF PENETRATION FACTOR IN ALPHA-DECAY. S. K. Dutta (Indian Assn. for the Cultivation of Science, Jadavpur, Calcutta). Indian J. Phys., 35: 299-306 (June 1961).

A general treatment of the calculation of the penetration probability of alpha particles through a potential barrier of Woods-Saxon diffuse type nuclear potential along with the Coulomb potential is given according to the one-body model for arbitrary values of the angular momentum of the emitted alpha particles. In the region where practically only the Coulomb potential is present the rigorous solution of Schrödinger equation is taken from that of Abramowitz. Near the nuclear boundary where both the potentials operate, the Schrödinger equation is solved by an ingenious method by Lanczos. (auth)

**32739** THE HALF-LIFE OF CARBON-14. W. B. Mann, W. F. Marlow, and E. E. Hughes (National Bureau

of Standards, Washington, D. C.). Intern. J. Appl. Radiation and Isotopes, 11: 57-67(Sept. 1961). (In English)

The half-life of  $C^{14}$  was determined with an accuracy believed to be higher than that of previously reported values. Carbon dioxide was liberated by the action of perchloric acid on barium carbonate which contained  $C^{14}$  in approximately 44% isotopic abundance. Samples of this  $C^{14}$  dioxide were analyzed mass spectrometrically, and other portions were diluted quantitatively with inert carbon dioxide and counted in the NBS length-compensated internal gas counters. Technical difficulties encountered in this work, which are characteristic of this type of experiment, particularly problems of adsorption and the methods used to overcome them, are discussed in detail. On the basis of a thorough analysis of all results obtained, the half-life of  $C^{14}$  is believed to be  $5760 \pm 50$  years, where the indicated uncertainty denotes an estimated over-all probable error of the result. (auth)

**32740** THE HALF-LIFE OF CARBON-14. D. E. Watt, D. Ramsden, and H. W. Wilson (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Intern. J. Appl. Radiation and Isotopes, 11: 68-74(Sept. 1961). (In English)

Specific activity measurements on pure samples of  $CO_2$  containing respectively 45 and 2%  $C^{14}$  by atoms, using mass spectrometry and proportional counting, have resulted in a new value of  $5780 \pm 65$  years for the  $C^{14}$  half-life. Gas adsorption difficulties have been surmounted by careful gas handling and the introduction of an adsorption test. Counting rate corrections for dead-time losses, end effect, wall effect and discriminator bias have been determined. (auth)

**32741** RELATIVE YIELDS OF THE ISOMERIC PAIRS  $^{68}Zn-^{69m}Zn$  AND  $^{52}Mn-^{52m}Mn$  IN SOME SPALLATION REACTIONS INDUCED BY 20-153 MEV PROTONS. I. B. Håller and G. Rudstam (Univ. of Uppsala). J. Inorg. & Nuclear Chem., 19: 1-8(Sept. 1961). (In English)

The ratio between the spallation yield of the high-spin isomer and that of the low-spin isomer was measured for the isomeric pairs  $Zn^{68g}-Zn^{69m}$  and  $Mn^{52g}-Mn^{52m}$  as a function of the irradiation energy and of the target used. For a given irradiation energy the yield ratio increases with increasing mass difference between target and isomer pair. A qualitative explanation of this effect is given. (auth)

**32742** DYSPROSIUM-154, A LONG-LIVED  $\alpha$ -EMITTER. R. C. Macfarlane (Univ. of California, Berkeley). J. Inorg. & Nuclear Chem., 19: 9-12(Sept. 1961). (UCRL-9335). (In English)

Gadolinium oxide, enriched in  $Gd^{154}$ , was bombarded with 48 Mev  $\alpha$  particles to form dysprosium isotopes.  $\alpha$ -Pulse-analysis of the chemically separated dysprosium resulted in the observation of a new weak  $\alpha$  activity of  $2.85 \pm 0.05$  Mev energy. This activity was assigned to  $Dy^{154}$  on the basis of a rough excitation function and consideration of  $\alpha$ -decay systematics of the neighboring dysprosium isotopes. The  $\alpha$ -half life was calculated as approximately  $1 \times 10^8$  years by estimating the amount of  $Dy^{154}$  produced and comparing it with the  $\alpha$ -count rate. A lower limit of 10 years for the  $\beta$ -decay half life was established on the basis of the absence of the prominent  $\gamma$  radiation of  $Tb^{154}$  in the photon spectrum. (auth)

**32743** LIGHT ISOTOPES OF RUBIDIUM FORMED IN  $^3He$  BOMBARDMENTS OF BROMINE. K. F. Chackett and G. A. Chackett (Univ. of Birmingham, Eng.). J. Inorg. & Nuclear Chem., 19: 13-15(Sept. 1961). (In English)

A light isotope of rubidium  $Rb^{79}$ , first was prepared along with  $Rb^{81}$  and  $Rb^{82}$  by bombarding bromine with  $He^3$  ions at 27 Mev. The mass assignment made by the earlier workers was fully confirmed by a genetic experiment and

characterization of the  $Kr^{79}$  daughter. The half life is  $20.9 \pm 0.8$  min. (auth)

**32744** SEARCH FOR AN ANTIMONY ISOTOPE WITH A 30 DAYS HALF-LIFE. M. C. Palcos R. Radicella, J. Rodriguez (National Atomic Energy Commission, Buenos Aires). J. Inorg. & Nuclear Chem., 19: 182-3(Sept. 1961). (In English)

Experiments were performed to determine the existence and nuclear properties of an antimony isotope with a 30 day half life. In the antimony fraction obtained from thermal fission 30 days from the end of the irradiation, only the half lives of  $Sb^{127}$  and  $Sb^{125}$  were observed. In fission induced by 28 Mev deuteron, all the isotopes with half lives longer than 30 days were found. The decay curves of the gamma activity were obtained by integration of several parts of the spectra taken at different times, and no 30 day half life was observed. It was concluded that in thermal fission and fission induced by 28 Mev deuterons on natural uranium no antimony isotope of 30 days half life is formed. (P.C.H.)

**32745** NUCLEAR ELASTIC SCATTERING OF PHOTONS NEAR THE PARTICLE THRESHOLD ENERGY [PART] I. Tsutomu Tohei, Masumi Sugawara, Shigeki Mori, and Motoharu Kimura (Tôhoku Univ., Sendai). J. Phys. Soc. Japan, 16: 1657-63(Sept. 1961). (In English)

The elastic scattering of photons near the particle threshold energy was studied for Al, Si, S, K, Ca, Ni, Cu, Cd, Sn, Pb, and Bi. The bremsstrahlung x rays from a 25 Mev betatron were used. The pulse of the primary x rays was expanded up to about 30  $\mu$  sec to decrease the pile-up effect. The scattered photons were detected at the scattering angle of 120 degrees with the scintillation spectrometer using a NaI(Tl) crystal and a 30 channel pulse height analyzer gated by the expansion signal of the betatron orbit. The energy at which the cross section has a peak was compared with the particle threshold energy and the value of the cross section was compared with that of particle emission. (auth)

**32746** SOME NEW ACTIVITIES PRODUCED BY FAST NEUTRON BOMBARDMENTS. Kasuke Takahashi, Tokihiro Kuroyanagi, Haruo Yuta, Kyûya Kotajima, Kunio Nagatani, and Haruhiko Morinaga (Tôhoku Univ., Sendai). J. Phys. Soc. Japan, 16: 1664-74(Sept. 1961). (In English)

New nuclides were produced in fast neutron bombardments of Ge, Mo, Gd, Er, Yb, and Hf. Radiation characteristics were determined using beta and gamma spectrometers and analyzed in the light of the unified model and conventional nuclear level systematics. (L.N.N.)

**32747** WEAK GAMMA RAYS IN THE DECAY OF  $La^{140}$ . Hidekuni Takekoshi, Naomoto Shikazono, and Poh-Kun Tseng (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan, 16: 1674-7(Sept. 1961). (In English)

Weak gamma rays of energy 0.63 Mev were found in the decay of  $La^{140}$  by means of a scintillation summing Compton spectrometer. These gamma rays are ascribed to the transition between the 2.53-Mev and 1.90-Mev states of  $Ce^{140}$ . The transition between this 1.90-Mev state and the 1.60-Mev state was not detected. Results of present investigations on the conversion electrons and gamma rays support the suggestion of Dželepov et al, that the 1.90-Mev state is a  $O^+$  one. (auth)

**32748** INTERNAL MAGNETIC FIELD IN RARE EARTH METALS. Jun Kondo (Tokyo Univ.). J. Phys. Soc. Japan, 16: 1690-1(Sept. 1961). (In English)

The effective magnetic field at nuclei in rare earth metals was calculated. The contribution from the orbital angular momentum of 4f-electrons was found to be several thousand kilo-gauss. (auth)



**32749** TEMPERATURE DEPENDENCE OF NUCLEAR RESONANCE ABSORPTION LINE WIDTH IN  $\text{Dy}^{161}$ . Poh-Kun Tseng, Naomoto Shikazono, Hidekuni Takekoshi, and Tokio Shoji (Japan Atomic Energy Research Inst., Tokyo). *J. Phys. Soc. Japan*, 16: 1790 (Sept. 1961). (In English)

The spectrum of the recoilless resonance absorption of the 25.7-keV gamma rays in the decay of  $\text{Tb}^{161}$  was measured. A  $\text{Dy}_2\text{O}_3$  absorber and  $\text{Tb}^{161}$  emitter embedded in  $\text{Gd}_2\text{O}_3$  were used, and the temperature of the  $\text{Dy}_2\text{O}_3$  absorber was varied. The width of the absorption line was found to be a function of the absorber temperature. No hyperfine structure was observed, since the emission and absorption lines are continuous by nature, due to the paramagnetic relaxation. (L.N.N.)

**32750** A STUDY OF NUCLEAR POTENTIAL ENERGY SURFACES AND GAMMA VIBRATIONS. Daniel R. Bès. (Kgl. Danske Videnskab. Selskab, Mat.-fys. Medd., 33: 1-39 (1961). (In English)

The theory of the collective properties of the nuclear shell model has progressed due to the introduction of the simple pairing force to simulate the residual nucleonic interaction. Within the framework of the adiabatic approximation, the consequences of this model for the  $\gamma$ -dependent terms of the nuclear potential energy surface are studied. The simplified case of nucleons in a harmonic oscillator potential is considered first. Then, the energies and transition probabilities are calculated for  $\gamma$ -vibrations of deformed nuclei of axial symmetric shape. Numerical calculations, based on realistic wave functions for nucleons in deformed nuclei, were performed in a few cases and are compared with empirical data. (auth)

**32751** THE ELASTIC AND INELASTIC SCATTERING OF PROTONS BY MAGNESIUM IN THE ENERGY RANGE FROM 7.3 MEV TO 15.9 MEV. K. Matsuda, Y. Nagahara, Y. Oda, N. Yamamuro, and S. Kobayashi (Tokyo Univ.). *Nuclear Phys.*, 27: 1-24 (1961). (In English)

Twenty-seven proton angular distributions for the elastic scattering from magnesium and for the inelastic scattering from  $\text{Mg}^{24}$ , leading to the first excited state at 1.37 MeV, are presented in the energy range from 7.32 to 15.85 MeV. The elastic angular distribution shows generally maxima and minima of the diffraction type. The absolute cross sections at fixed angles, however, vary appreciably from energy to energy, particularly at backward angles. The angular distribution for inelastic scattering varies remarkably with the incident energy, especially in the energy range less than 12 MeV. The integrated cross section for the inelastic scattering also shows variations with energy. The results are compared with other experiments. The emitted spectrum of inelastic protons is also presented in connection with the study of angular distribution. The conclusion is that neither the simple theory of direct process and/or optical model, nor that of compound process explains the results completely. (auth)

**32752** THE E.C./ $\beta^+$  RATIO IN  $\text{Pr}^{139}$ . O. Borello, S. Costa, and F. Ferrero (Università, Turin and Istituto Nazionale Fisica Nucleare, Turin). *Nuclear Phys.*, 27: 25-7 (1961). (In English)

The previously reported value of the E.C./ $\beta^+$  ratio for  $\text{Pr}^{139}$  was remeasured and found to be 4.8. (auth)

**32753** POLARIZATION IN  $\text{C}^{12}$  (p,p) SCATTERING FROM 5 TO 10.5 MEV. J. E. Evans (Atomic Energy Research Establishment, Harwell, Berks, Eng.). *Nuclear Phys.*, 27: 41-5 (1961). (In English)

The measurement of the polarization in  $\text{C}^{12}$  (p,p) scattering at three different energies, using a carbon polarimeter with the Harwell tandem generator, was described. The

polarimeter, which was made more efficient, was calibrated using one of the three original measurements, and used to determine the polarization at several angles in the energy range from 5 to 10.5 MeV. The results provide data for using  $\text{C}^{12}$  as an analyzer of proton polarization. They also provide a sensitive check on the accuracy of phase shift analyses of  $\text{C}^{12}$  (p,p) scattering. Finally, it is of interest to compare the gross behavior below 10 MeV with optical model predictions. (auth)

**32754** ALPHA-DEUTERON MODEL OF THE  $\text{Li}^6$  NUCLEUS AND THE  $\text{Be}^9(\text{Li}^6, \alpha)\text{B}^{11}$  REACTION. M. L. Rustgi (National Research Council, Ottawa). *Nuclear Phys.*, 27: 58-65 (1961). (In English)

The angular distributions of the particles emitted in  $(\text{Li}^6, \alpha)$  and  $(\text{Li}^6, d)$  reactions are calculated under the assumption that they are stripping processes. An alpha-deuteron model of the  $\text{Li}^6$  nucleus is used. The Coulomb effects of the interacting particles and the nuclear interaction between the outgoing particles are neglected. The derived formulas are compared with the experimental data of Leigh and Blair on the differential cross sections of the  $\text{Be}^9(\text{Li}^6, \alpha)\text{B}^{11}$  reaction. The general shapes of the calculated angular distributions are similar to those of the experimental data, but there is a lack of agreement between theory and experiment at large angles. (auth)

**32755** THE RESONANT SCATTERING OF GAMMA RAYS IN  $^{177}\text{Hf}$ . W. D. Hamilton and B. S. Sood (The University, Birmingham, Eng.). *Nuclear Phys.*, 27: 66-74 (1961). (In English)

Matched hafnium oxide and tantalum carbide scatterers were used to determine the intensities of resonant and fluorescent scattered  $\gamma$  rays from the 113 and 321 keV levels in  $\text{Hf}^{177}$ ; the source of radiation was  $\text{Lu}^{177}$  in the form of lutetium oxide. The resonant scattering condition was provided by the thermal broadening of the level widths, and the resonant fluorescent cross sections were found relative to the known Rayleigh scattering cross sections. The partial mean lives for the  $\gamma$ -transitions have the values  $\tau$  (113 keV;  $E_2$ ) =  $1.5 \pm 0.5$  nsec and  $\tau$  (321 keV;  $E_1$ ) =  $17 \pm 5$  nsec. When compared to the single particle estimates, these results indicate an enhancement factor of almost 330 for the 113 keV transition, but a hindering of 321 keV transition by a factor greater than  $10^6$ . The results, in general, are consistent with previous investigations and may be interpreted on the basis of the Nilsson model. (auth)

**32756** MEASUREMENT OF K CONVERSION COEFFICIENT OF 279 KEV GAMMA RADIATION IN  $\text{Tl}^{203}$ . J. P. Hurley and J. M. Ferguson (Naval Radiological Defense Lab., San Francisco). *Nuclear Phys.*, 27: 75-8 (1961). (In English)

The K conversion coefficient of the 279-keV transition in  $\text{Tl}^{203}$  was determined by measuring the relative intensities of the 279-keV gamma ray and the K x rays from a  $\text{Hg}^{203}$  source. Using the value  $\omega_K = 0.955$  for the fluorescent yield, the conversion coefficient was determined to be  $\alpha_K = 0.175 \pm 0.0036$ . (auth)

**32757** THE USE OF POLARIZED DEUTERONS TO STUDY THE D + D REACTIONS. J. R. Rook and L. J. B. Goldfarb (Univ. of Manchester, Eng.). *Nuclear Phys.*, 27: 79-93 (1961). (In English)

It is shown that further information on the spin transitions involved in the D + D reactions at low energies ( $E_D \lesssim 1$  MeV) may be obtained by the use of polarized deuteron beams, but that a complete determination of the reaction matrix elements requires two double polarization measurements. The selection rules on the spin transitions are discussed in terms of the internucleon forces and the earlier

formulas giving the energy dependence of the cross sections and polarization are slightly modified to give a further degree of freedom in fitting the experimental data. (auth)

### 32758 STUDY OF THE $O^{16}(d,n)F^{17}$ REACTION.

O. Dietzsch, Y. Hama, E. W. Hamburger, and F. C. Zawislak (Universidade, São Paulo, Brazil). *Nuclear Phys.*, 27: 103-11(1961). (In English)

The  $O^{16}(d,n)F^{17}$  g.s. reaction was investigated in the energy range from threshold (1.83 Mev) to 2.4 Mev. Yield curves were obtained at 3 angles and angular distributions at 7 energies. The angular distributions are isotropic near threshold but become quite anisotropic at higher energies; they are not symmetric about  $90^\circ$  and are suggestive of a direct reaction mechanism. An attempt was made to explain the experimental results by stripping theory, taking the distortion of the deuteron wave by the Coulomb field into account. At low energies the calculation yields results in agreement with experiment, but at higher energies a large discrepancy exists. This agreement appears to be related to the existence of resonances in the yield curve at the higher energies. (auth)

### 32759 THE SPIN AND PARITY OF THE 648 KEV

RESONANCE IN  $Mg^{26}(p,\gamma)Al^{27}$ . Rolf Nordhagen (Fysisk Institutt, Universitetet i Oslo, Blindern, Norway). *Nuclear Phys.*, 27: 112-14(1961). (In English)

The spin and parity of the 648 kev resonance in  $Mg^{26}(p,\gamma)Al^{27}$  is discussed and tentatively assumed to be  $5/2^-$ . (auth)

### 32760 THE SHAPE OF THE ATOMIC NUCLEUS AND

ZERO SPIN EXCITED STATES. A. S. Davydov, V. S. Rostovskii (Rostovsky), and A. A. Chaban (Moscow State Univ.). *Nuclear Phys.*, 27: 134-43(1961). (In English)

Collective excited states corresponding to rotation,  $\beta$  and  $\gamma$  oscillations of the surface of even nuclei are investigated. The probabilities for EO transitions between these states and E2 transitions from zero spin levels are calculated for spherical nuclei and non-spherical nuclei with  $\gamma_0 = 0$  as well as  $\gamma_0 \neq 0$ . It is shown that the parameter  $\gamma$  in the theory of rotational states of non-axial nuclei can be identified with the most probable value of  $\gamma_m$  corresponding to zero oscillations of the nuclear surface about the equilibrium position. (auth)

### 32761 ON THE MECHANISM OF INTERACTION OF

FAST PROTONS WITH NUCLEI. K. D. Tolstov (Joint Inst. for Nuclear Research, Dubna, USSR). *Nuclear Phys.*, 27: 144-7(1961). (In English)

Results of publications concerned with interactions of 9-Bev protons with photoemulsion nuclei are discussed. The comparison drawn with recourse to data on nucleon-nucleon collisions warrants the conclusion that the cascade mechanism of interaction with nuclei is valid. (auth)

### 32762 THE RATIO OF ASYMMETRIC TO SYMMETRIC

FISSION IN p-WAVE NEUTRON FISSION OF  $U^{235}$ . J. G. Cuninghame, G. P. Kitt, and E. R. Rae (Atomic Energy Research Establishment, Harwell, Berks, Eng.). *Nuclear Phys.*, 27: 154-65(1961). (In English)

Radiochemical measurements were made of the peak-to-valley ratio of the mass-yield curve for neutron induced fission of  $U^{235}$  at neutron bombarding energies from 65 kev to 14 Mev, with emphasis on the region about 125 kev. In this region, where p-wave interactions predominate, the peak-to-valley ratio was found to be  $\approx 45\%$  higher than for thermal neutron fission, contrary to the trend suggested by the channel theory of fission. (auth)

### 32763 SURFACE DIRECT INTERACTION OF 14 MEV

NEUTRONS WITH FLUORINE. E. Kondaiah, M. L. Jhingan, and C. Badrinathan (Tata Inst. of Fundamental Research, Bombay). *Nuclear Phys.*, 27: 166-76(1961). (In English)

The energy and angular distribution of charged particles arising when 14-Mev neutrons are incident on a foil of Teflon are studied using nuclear emulsion detector. The energy distribution showed three peaks at 530, 220, and 120  $\mu m$  ranges. The energies of these peaks assuming them to be comprised of protons, deuterons or tritons are given and they agree with those to be expected from known levels of the final nuclei. In general the emission at forward angles is found to be much more than at backward angles and is  $(5.5 \pm 0.5)$  times that at backward angles for all the three groups taken together. Experimental angular distributions of all the three groups are given. In two cases, these distributions are compared with theoretical distributions assuming surface direct interactions to be taking place. The agreement between theory and experiment is good enough to draw conclusions regarding parities of the levels involved. The energy and angular distributions of one of these groups indicate a new level in  $O^{13}$  at 4 Mev. (auth)

### 32764 THE HALF-LIFE OF LONG-LIVED LUTETIUM-

176. A. McNair (Atomic Weapons Research Establishment, Aldermaston, Berks. Eng.). *Phil. Mag.* (8), 6: 851-6(July 1961).

The half-life of the odd-odd naturally occurring isotope lutetium-176 is shown to be  $(3.6 \pm 0.1) \times 10^{10}$  years, from independent measurements both of the rate of gamma and of electron emission. (auth)

### 32765 TENSOR TYPE ( $f_{Bij}$ ) COMPONENT IN THE

2.31-MEV  $\beta$  TRANSITION OF  $Sb^{124}$ . R. M. Steffen (Purdue Univ., Lafayette, Ind.). *Phys. Rev.*, 124: 145-9(Oct. 1, 1961).

The  $\beta$ - $\gamma$  directional correlation of the first-forbidden 2.31-Mev  $\beta$  transition of  $Sb^{124}$  and of the 0.603-Mev  $\gamma$  ray of  $Te^{124}$  was measured. The integral  $\beta$ - $\gamma$  directional correlation measured at an average  $\beta$  energy,  $\bar{W} = 4.8$ , is represented by  $W_{\beta\gamma}(\theta, \bar{W} = 4.8) = 1 - (0.390 \pm 0.011)P_2(\cos\theta) + (0.004 \pm 0.013)P_4(\cos\theta)$ . The negligibly small  $P_4(\cos\theta)$  term provides additional evidence against a second-forbidden  $\beta$  transition. The energy dependence of the anisotropy coefficient  $A_2(W)$  in the correlation function  $W_{\beta\gamma}(\theta, W) = 1 + A_2(W) \times P_2(\cos\theta)$  was measured. The experimental values of  $A_2(W)$  exclude the possibility of a pure  $f_{Bij}$  transition, but give conclusive evidence that the  $f_{Bij}$  matrix element contributes very significantly to the 2.31-Mev  $\beta$  transition of  $Sb^{124}$ . In fact, the directional correlation data are well represented, if  $C_A f_{Bij} \approx -C_V f_{ia} + \xi C_V \int r - \xi C_A \int \sigma \times r$ , where  $\xi = Z\alpha/2R$ . (auth)

### 32766 DETERMINATION OF THE NUCLEAR MATRIX

ELEMENTS IN THE 2.31-MEV  $\beta$  TRANSITION OF  $Sb^{124}$  THROUGH MEASUREMENT OF THE  $\beta$ - $\gamma$  (CIRCULARLY POLARIZED) ANGULAR CORRELATION. P. Alexander and R. M. Steffen (Purdue Univ., Lafayette, Ind.). *Phys. Rev.*, 124: 150-7(Oct. 1, 1961).

The degree of circular polarization ( $P_c$ ) of the 0.603-Mev gamma radiation following the first-forbidden  $\beta$  transition from the  $3^-$  ground state of  $Sb^{124}$  to the  $2^+$  first excited state of  $Te^{124}$  was measured. The dependence of  $P_c$  on the angle  $\theta_{\beta\gamma}$  between the  $\beta$  and  $\gamma$  momentum vectors was determined. Representative values of  $P_c(\theta_{\beta\gamma})$  at some of the angles  $\theta_{\beta\gamma}$  measured are  $P_c = 0.061 \pm 0.071$  at  $\theta_{\beta\gamma} = 105^\circ$ ,  $P_c = 0.349 \pm 0.083$  at  $\theta_{\beta\gamma} = 122^\circ$ ,  $P_c = 0.604 \pm 0.054$  at  $\theta_{\beta\gamma} = 152^\circ$ , and  $P_c = 0.373 \pm 0.071$  at  $\theta_{\beta\gamma} = 168^\circ$ . These values were obtained at  $\bar{W} = 4.6$ . The 2.31-Mev  $\beta$  transition of  $Sb^{124}$  is known to contain an unusually large contribution from the  $f_{Bij}$  matrix element (which describes the component of the lepton field carrying away two units of angular momentum). The measured  $\beta$ - $\gamma$  circular-polarization correlation data, the  $\beta$ - $\gamma$  directional correlation, and spectral shape data were analyzed by use of a digital computer on the basis of



the Kotani parameters  $Y$ ,  $x$ ,  $u$ , and  $z$ . A somewhat generous summary of the final data may be given by  $Y = 0.6 \pm 0.3$ ,  $x = -0.055 \pm 0.105$ ,  $u = -0.060 \pm 0.140$ ,  $z = 1$ . Values of the nuclear matrix elements are extracted from the ft value of the 2.31-Mev  $\beta$  transition and the measured Kotani parameters, yielding  $fB_{ij}/R = \pm(1.4 \pm 0.2) \times 10^{-2}$ ,  $f_r/R = \mp(9.3 \pm 17.6) \times 10^{-4}$ ,  $f_{ig} \times r/R = \mp(8.1 \pm 18.9) \times 10^{-4}$ ,  $f_{i\alpha} = \pm(1.6 \pm 0.8) \times 10^{-4}$ .  $R$  is the nuclear radius of  $Sb^{124}$  in units of  $\hbar/mc$ . The significance of suppression of the matrix elements other than  $fB_{ij}$  is discussed. (auth)

**32767** L TO K RATIOS IN THE ELECTRON CAPTURE DECAY OF  $W^{181}$  AND  $Ta^{179}$ . R. C. Jopson, Hans Mark, C. D. Swift, and J. H. Zenger (Univ. of California, Livermore). Phys. Rev., 124: 157-61 (Oct. 1, 1961). (UCRL-6207)

The L to K ratios in the electron capture decay of the isotopes  $Ta^{179}$  and  $W^{181}$  have been redetermined. Thin (0.060 in.) NaI crystals with thin (0.002 in.) Be windows were used to detect the L and K x rays. The partial fluorescence yields of the L subshells of Hf and Ta were also measured by determining the coincidence rates between the L and the K x rays emitted by the sources. It is necessary to know the fluorescence yields if the L to K ratios are to be determined from the measured intensities of the L and the K x rays. The L to K ratio of  $Ta^{179}$  was found to be  $0.63 \pm 0.06$ , which implies a total decay energy of approximately  $115 \pm 5$  kev for this isotope. This energy is consistent with the observation that no gamma rays accompany the decay of  $Ta^{179}$  since the first excited level of Hf<sup>179</sup> has an energy (122 kev) exceeding the total decay energy of  $Ta^{179}$ . The L to K ratio of  $W^{181}$  was found to be  $0.23 \pm 0.05$ , from which a decay energy of approximately 260 kev is computed. This result is in agreement with the fact that two weak gamma rays are emitted by the source, one at 137 kev and the other at 152 kev. These gamma rays correspond to excited levels in  $Ta^{181}$ . These gamma rays are in coincidence with the L x rays emitted by the source but not with the K x rays, which means that the total decay energy of  $W^{181}$  must exceed 166 kev. The L to K capture ratios reported are not in good agreement with previously reported values. (auth)

**32768** ACCURACY OF THE SUPERCONDUCTIVITY APPROXIMATION FOR PAIRING FORCES IN NUCLEI. A. K. Kerman (Argonne National Lab., Ill.), R. D. Lawson, and M. H. MacFarlane. Phys. Rev., 124: 162-7 (Oct. 1, 1961).

The accuracy of the superconductivity approximation for pairing forces in nuclei is studied. To this end the pairing force for certain nuclei was diagonalized and compared with the approximate calculation of Kisslinger and Sorensen. When the energy is computed by use of the approximate-wave function, which is not an eigenfunction of the number operator, it is found that the excitation energies of the low-lying states with seniority one and two are correct to within 200 kev, whereas the ground-state energies are usually not given to better than 500 kev. The wave function obtained by projecting out and normalizing that part of the variational trial function that corresponds to the correct number of particles is found to agree closely with the exact energy eigenfunction. Overlap integrals greater than 98% are found in all cases considered. The expectation values of the pairing Hamiltonian with respect to these projected wave functions are therefore in excellent agreement with the exact energy eigenvalues. The variational aspects of the superconductivity approximation are also discussed briefly. (auth)

**32769** DECAY OF NEODYMIUM-147. M. R. Gunye, R. Jambunathan, and Babulal Saraf (Atomic Energy Es-

tablishment, Trombay, India). Phys. Rev., 124: 172-7 (Oct. 1, 1961).

The decay of  $Nd^{147}$  has been investigated using scintillation spectroscopy and coincidence technique. The following sequences of gamma emission have been uniquely established: 91-kev gamma ray is in coincidence with 120, 199, 277, 322, 400, 442, and 599-kev gamma rays; 120-kev gamma ray with 322- and 413-kev gamma rays; 199-kev gamma ray with 400- and 491-kev gamma rays; 277-kev gamma ray with 322- and 413-kev gamma rays; and 310-kev gamma ray with 322- and 413-kev gamma rays. On the basis of these gamma-gamma sequences, the levels of  $Pm^{147}$  at 91, 413, 491, 533, 690, and 723 kev above the ground state are unambiguously established. A critical analysis of the observed coincidence spectra shows that the levels at 182 and 230 kev, suggested by other workers, either do not exist or, if they exist, are not populated by any beta transition of intensity more than a percent or by any gamma transition from other higher energy levels, of intensity more than 0.1%. (auth)

**32770** DIRECTIONAL CORRELATION OF GAMMA TRANSITIONS IN PROMETHIUM-147. Babulal Saraf, R. Jambunathan, and M. R. Gunye (Atomic Energy Establishment, Trombay, India). Phys. Rev., 124: 178-82 (Oct. 1, 1961).

The angular correlations of five different gamma-ray cascades, involving the states of  $Pm^{147}$ , excited in the decay of  $Nd^{147}$ , have been studied. The observed correlation functions for the various cascades are as follows:  $W_{(599\theta_{91})} = 1 + (0.056 \pm 0.028)P_2(\cos\theta) - (0.049 \mp 0.034)P_4(\cos\theta)$ ;  $W_{(442\theta_{91})} = 1 + (0.065 \pm 0.020)P_2(\cos\theta) - (0.035 \mp 0.025)P_4(\cos\theta)$ ;  $W_{(199\theta_{400})} = 1 - (0.054 \pm 0.020)P_2(\cos\theta) + (0.043 \mp 0.025)P_4(\cos\theta)$ ;  $W_{(199\theta_{491})} = 1 + (0.095 \pm 0.028)P_2(\cos\theta) + (0.014 \mp 0.034)P_4(\cos\theta)$ ; and  $W_{(120\theta_{322})} = 1 + (0.035 \pm 0.020)P_2(\cos\theta) - (0.001 \mp 0.025)P_4(\cos\theta)$ . The analysis of the above correlation functions with the ground-state spin of  $Pm^{147}$  as  $\frac{7}{2}$ , and the consideration of the log ft values for the beta transitions from  $Nd^{147}$  state of spin  $\frac{5}{2}$ , give the spin values for the 91, 413, 491, 533, and 690-kev excited states as  $\frac{5}{2}$ ,  $\frac{7}{2}$ ,  $\frac{7}{2}$ ,  $\frac{5}{2}$ , and  $\frac{5}{2}$ , respectively. The data of Bishop et al. and Ambler et al. on nuclear alignment experiments have been reanalyzed. The results are consistent with the above spin assignment of  $\frac{5}{2}$  for both the 91- and 533-kev levels. (auth)

**32771** CAPTURE-GAMMA-RAY SPECTRUM OF  $Cd^{113}(n,\gamma)Cd^{114}$  AND THE ASSOCIATED ENERGY LEVELS IN  $Cd^{114}$ . Robert K. Smither (Argonne National Lab., Ill.). Phys. Rev., 124: 183-92 (Oct. 1, 1961).

The capture gamma-ray spectrum of  $Cd^{113}(n,\gamma)Cd^{114}$  was investigated with the Argonne 7.7-m bent-crystal spectrometer. The observed spectrum consisted of 119 gamma rays with energies below 2 Mev. These precision energy measurements were combined with a series of coincidence experiments to modify and extend the level scheme of  $Cd^{114}$ . The errors in the energy values of five previously observed levels are reduced by a factor of 10. Their new values are found to be  $557.8 \pm 0.1$ ,  $1208.4 \pm 0.2$ ,  $1282.2 \pm 0.2$ ,  $1304.9 \pm 0.3$ , and  $1362.9 \pm 0.3$  kev. Five new levels are established at  $1133.1 \pm 0.2$ ,  $1730.3 \pm 0.2$ ,  $1839.9 \pm 0.3$ ,  $1958.3 \pm 0.3$ , and  $2202.4 \pm 0.3$  Mev. Eight more levels are suggested at  $1607.8 \pm 0.3$ ,  $2048.3 \pm 0.4$ ,  $2225.1 \pm 0.4$ ,  $2392.5 \pm 0.4$ ,  $2573.8 \pm 0.5$ ,  $2868.0 \pm 0.7$ ,  $3216.8 \pm 0.8$ , and  $3484.7 \pm 0.8$  kev. The limits placed on the spins and parities of these levels by the observed capture gamma rays are discussed. (auth)

**32772** GAMMA-RAY DECAY OF THE 7.66-MEV LEVEL OF  $C^{12}$ . David E. Alburger (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 124: 193-8 (Oct. 1, 1961). (BNL-5476)

Proton-gamma-gamma triple coincidence measurements have been carried out on the  $B^{10}(He^3, p)C^{12}$  reaction at  $E_{He^3} = 2.2$  Mev. Protons were detected in a  $\frac{3}{4}$ -in. diameter CsI crystal subtending a solid angle of 27% of  $4\pi$  at the target, the gamma-ray detectors were 5 in.  $\times$  5 in. NaI crystals, and the coincidence resolving time was  $8 \times 10^{-9}$  sec. The spectrum of protons in triple coincidence with the two gamma-ray detectors, each channelled from 2.4 to 5.0 Mev, contains a line corresponding to the alpha-emitting 7.66-Mev  $0^+$  second-excited state of  $C^{12}$ . This line is interpreted as resulting from the 3.23 – 4.43-Mev cascade gamma-ray decay of the 7.66-Mev level through the 4.43-Mev  $2^+$  first-excited state. The ratio of the triples to singles counting rates of the 7.66-Mev proton line, when corrected by the appropriate factors for gamma-ray efficiency, leads to a 3.23-Mev gamma-ray branch of  $(3.3 \pm 0.9) \times 10^{-4}$  per decay of the 7.66-Mev level. This branch, which compares with a previous theoretical estimate of  $\sim 2 \times 10^{-4}$ , is stronger than the direct ground-state transition by a factor of 50. (auth)

**32773 ELASTIC SCATTERING OF 8-MEV POLARIZED PROTONS.** L. Rosen, J. E. Brolley, Jr., M. L. Gursky, and L. Stewart (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 124: 199-202 (Oct. 1, 1961).

The angular dependence of the polarization produced in the elastic scattering of 8-Mev protons by complex nuclei has been measured for 23 elements. The polarization exhibits a smooth dependence on mass number and scattering angle for most of the elements studied. The systematics in the angular distributions are reproduced by an optical model calculation in which only the radius is permitted to vary. (auth)

**32774 SEARCH FOR A  $\beta^-$  BRANCH IN  $I^{124}$ .** C. M. Merrihue (Univ. of California, Berkeley). Phys. Rev., 124: 208-9 (Oct. 1, 1961).

A mass spectrometric search for a  $\beta^-$  branch in 4.2-day  $I^{124}$  has been made by examining the isotopic composition of xenon from deuteron-irradiated tellurium. The expected  $\beta^-$  branch, based on nuclear mass data and ft values, is 0.017%. There was good agreement between calculated and measured isotopic composition. No  $Xe^{124}$  was detected, so an upper limit of 0.1% was established for this branching. (auth)

**32775 CALCULABLE MODEL FOR COMPOUND NUCLEUS-DIRECT INTERACTION INTERFERENCE.** Leonard S. Rodberg (Univ. of Maryland, College Park). Phys. Rev., 124: 210-12 (Oct. 1, 1961).

The formation of the compound nucleus is described. The importance of two-particle excited states is stressed and the possibility of experimentally observing the interference between the associated "two-particle resonances" and direct-interaction processes is discussed. Formulas are presented which permit the calculation of both the direct-interaction term and the amplitude associated with the resonance. (auth)

**32776 LEVEL STRUCTURE OF  $Sn^{118}$  AND  $Sn^{120}$  FROM THE DECAY OF Sb ISOTOPES.** H. H. Bolotin, A. C. Li, and A. Schwarzschild (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 124: 213-23 (Oct. 1, 1961). (BNL-5514)

The decay of 5-hr  $Sb^{118}$  and 6-day  $Sb^{120}$  was studied. The spins, parities, and multipole orders of the transitions in both Sn isotopes are characterized by  $7^- (E2)5^- (E1)4^- (E2)2^+ (E2)0^+$ . Level ordering in both isotopes was determined to differ from the previously accepted order. The spins and multipole order assignments were determined from angular correlation and internal conversion measurements in  $Sn^{118}$  and from a reinterpretation of similar

experimental results by Ikegami for  $Sn^{120}$ . All  $\beta$  decay is directly to the  $7^-$  states. The levels are at 2.57, 2.32, 2.28, and 1.23 Mev in  $Sn^{118}$  and 2.50, 2.30, 2.21, and 1.18 Mev in  $Sn^{120}$ . Half lives determined using delayed coincidence techniques were as follows: ( $7^-$ ),  $(2.3 \pm 0.1) \times 10^{-7}$  sec; ( $5^-$ ),  $(2.0 \pm 0.3) \times 10^{-8}$  sec in  $Sn^{118}$ ; and ( $7^-$ ),  $(1.12 \pm 0.10) \times 10^{-5}$  sec; ( $5^-$ ),  $(5.2 \pm 0.4) \times 10^{-6}$  sec in  $Sn^{120}$ . Reduced transition probabilities are compared with current theories. No crossover transitions were found in either decay except for a weak 1.090-Mev  $E3$  transition from the  $5^-$  to  $2^+$  levels in  $Sn^{118}$ , which has a reduced transition probability close to single-particle speed. Triple coincidence experiments determined a  $\beta^+$  to capture ratio of  $(1.6 \pm 0.1) \times 10^{-3}$  in the  $Sb^{118}$  decay yielding an inferred transition energy of 1.32 Mev. (auth)

**32777 ANGULAR DISTRIBUTION OF 2.6-MEV GAMMA RAYS FROM THE REACTION  $Pb^{208}(n, n'\gamma)Pb^{208}$ .** D. J. Donahue (Pennsylvania State Univ., University Park). Phys. Rev., 124: 224-6 (Oct. 1, 1961).

Gamma rays produced through inelastic scattering by lead of a collimated beam of fast neutrons from a reactor have been detected with a NaI(Tl) crystal. The relative yield of 2.6-Mev  $\gamma$  rays from  $Pb^{208}$  was measured as a function of the angle between the incident neutrons and outgoing  $\gamma$  rays. Good agreement is obtained between the experimental angular distribution and a calculated distribution based on a statistical model, and using quantum numbers  $3^-$  for the 2.6-Mev state in  $Pb^{208}$ . (auth)

**32778 CLASSICAL SELF-CONSISTENT NUCLEAR MODEL.** R. G. Seyler and C. H. Blanchard (Pennsylvania State Univ., University Park). Phys. Rev., 124: 227-32 (Oct. 1, 1961).

The Thomas-Fermi method in simplest form is applied to find the radial distribution of nucleons in a spherical nucleus in the absence of Coulomb forces. Saturation is obtained by hypothesizing a two-body force quadratically dependent on relative momentum. The effective one-nucleon potential energy is therefore velocity dependent. Solving the basic integral equation and imposing generally accepted values for the average and Fermi kinetic energies in the nuclear matter limit ( $A \rightarrow \infty$ ) give a solution exhibiting surface and saturated interior regions. Fixing one more parameter (the force range, taken to be  $\hbar/m_\pi c$ ) determines all numerical features (e.g., surface thickness, interaction strength) at reasonable values. (auth)

**32779 NEUTRON EMISSION FROM COMPOUND NUCLEAR SYSTEMS OF HIGH ANGULAR MOMENTUM.** H. W. Broek (Yale Univ., New Haven and Argonne National Lab., Ill.). Phys. Rev., 124: 233-45 (Oct. 1, 1961).

Measurements were made of the energy spectra and angular distributions of neutrons emitted with laboratory energies in the range from 1 to 10 Mev in reactions induced by 160-Mev oxygen-16 ions incident on thin targets of aluminum, nickel, copper, and gold. Spectra were obtained (at laboratory angles between  $30^\circ$  and  $150^\circ$ ) by analysis of the proton-recoil pulse-height spectra produced by the neutrons in a stilbene scintillation crystal. All spectra and angular distributions at these angles are consistent with the hypothesis of evaporation from compound nuclei. The energy spectra of neutrons emitted from the initial compound nuclei were calculated by use of statistical evaporation theory, both with and without modification to include (in a classical approximation) the effects of conservation of angular momentum. The dominant effect of conservation of angular momentum upon the calculated neutron spectra from the initial compound nuclei is a lowering of the nuclear emission temperature for the cases and parameters chosen. The meas-



ured spectra are compared to the spectra calculated both with and without the modification. The angular distributions are symmetric about  $90^\circ$  and peaked forward and backward. The total cross section for neutron production increases with increasing mass of the target atom, and is roughly 70% greater for copper than for nickel. This sudden increase is probably related to the greater neutron excess of copper. (auth)

**32780** EVIDENCE FOR CHARGE INDEPENDENCE IN MEDIUM WEIGHT NUCLEI. J. D. Anderson and C. Wong (Univ. of California, Livermore). *Phys. Rev. Letters*, 7: 250-2 (Sept. 15, 1961).

The neutron spectra from the  $V^{51}(p,n)Cr^{51}$  reaction exhibit a peak at a  $Cr^{51}$  excitation energy of 6.5 Mev. The properties of this peak suggest that a direct, charge-independent, charge-exchange reaction occurs in this region to a  $Cr^{51}$  state that is analogous to the  $V^{51}$  initial state. Charge independence is shown to imply that the  $Q$ -value for the reaction to the analogous final state equals the Coulomb energy difference  $\Delta E_c$  between the initial and final nuclei.  $Q$ - and  $\Delta E_c$ -values are found to agree closely for  $(p,n)$  reactions on  $V^{51}$ ,  $Fe^{56}$ , and  $Co^{59}$ . (T.F.H.)

**32781** QUASI-ELASTIC INTERACTION OF 155-Mev PROTONS WITH PROTONS IN  $Li^6$  AND  $Li^7$ . J. P. Garron (Laboratoire Joliot-Curie de Physique Nucleaire, Orsay, France), J. C. Jacmart, M. Riou, C. Ruhla, J. Teillac, C. Caverzasio, and K. Strauch. *Phys. Rev. Letters*, 7: 261-3 (Sept. 15, 1961).

The reaction  $(p,2p)$  on  $Li^6$  and  $Li^7$  is studied at a proton energy of 155 Mev. The proton spectra and angular correlations are determined and compared with theoretical predictions. (T.F.H.)

**32782** THE  $^{55}Mn(d,p)^{56}Mn$  REACTION. A. W. Dalton, G. Parry, H. D. Scott, and S. Swierszczewski (Univ. of Liverpool). *Proc. Phys. Soc. (London)*, 78: 404-8 (Sept. 1, 1961).

The energy spectra of the protons emitted from a manganese target when bombarded with 8.9 Mev deuterons were measured by magnetic analysis at angles of observation between  $5^\circ$  and  $60^\circ$ . Angular distributions of a number of proton groups were obtained and compared with theoretical stripping curves to obtain information on parities, spins, and reduced widths. The results were also compared with those of Schiffer, Lee, and Zeidman on gross structure in the proton spectra. (auth)

**32783** NUCLEAR INTERACTIONS IN THE  $p_{1/2}$ - $g_{7/2}$  CONFIGURATIONS. V. K. Thankappan, Y. R. Waghmare, and S. P. Pandya (Physical Research Lab., Ahmedabad, India). *Progr. Theoret. Phys. (Kyoto)*, 26: 22-8 (July 1961). (In English)

Zirconium<sup>90</sup> offers a good case for the study of  $T = 1$  levels in the  $p_{1/2}$ - $g_{7/2}$  subshells. It is found that a simple central two-body interaction can be constructed that gives correctly the energy levels of the  $(g_{7/2})^2$  configuration, and hence also the levels of a  $(g_{7/2})^1$  configuration. However, the same interaction fails to give correctly the levels of the other configurations,  $(p_{1/2})^1(g_{7/2})^1$  and  $(p_{1/2})^2$ . This simple two-body nuclear interaction is thus shown to be configuration-dependent. It is pointed out that experimental verification of the unobserved  $4^-$  level would be very helpful for further elucidation of this phenomenon. (auth)

**32784** BETA AND GAMMA EMISSION FROM ORIENTED NUCLEI. Hans Postma. Thesis, Groningen, Netherlands, Rijksuniversiteit, 1960. 126p.

Fundamentals of nuclear orientation are reviewed. The theory of  $\beta$  and  $\gamma$  emission from oriented nuclei is ex-

amined. Attention is given to: the asymmetry in  $\beta^+$  emission from  $Co^{58}$  and  $Mn^{52}$ ; the angular distribution and linear polarization of the  $\gamma$  rays emitted by  $Ho^{166m}$ ; and  $\beta^-$  emission from  $Ho^{166m}$  and  $Tb^{160}$ . The theory of  $\beta$  and  $\gamma$  emission from strongly deformed even-A nuclei is considered. (T.F.H.)

## Particle Accelerators

**32785** (BNL-5701) DESIGN STUDY FOR A 300-1000 BEV ACCELERATOR. (Brookhaven National Lab., Upton, N. Y.). Aug. 28, 1961. Contract AT(30-2)-GEN-16. 159p.

Design considerations for an alternating-gradient synchrotron-type (AGS-type) accelerator for energies of 300 to 1000 Bev are presented. Energies chosen for specific study are 400, 700, and 1000 Bev. The accelerator diameter may vary up to 6 km, and the output is on the order of  $10^{13}$ /sec. Attention is given to particle dynamics, machine parameters, injection, acceleration, magnets, vacuum systems, instrumentation and control systems, buildings and sites, and economic considerations. In addition, a system is studied in which an AGS is used to inject particles at 400 to 1700 Mev into a FFAG accelerator that utilizes a superconducting 100-kgauss magnet. (T.F.H.)

**32786** (JINR-P-758) ISSLEDOVANIYE DVIZHENIYA CHASTITS V KOL'TSEVOM FAZOTRONE. (Motion of Particles in Annular Phasotrons). A. A. Zhuravlev, I. N. Ivanov, M. Karmasin, V. I. Kotov, E. A. Mayae, V. A. Oboznyi, Yu. L. Obukhov, and V. A. Petrukhov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1961. 24p.

A method for measuring beam orbits and experiments for determining orbit distortions resulting from perturbations induced in different sections of the electromagnet are described. Experimental data are correlated with theoretical. A resonance method for determining frequencies of free oscillations and beam behavior during various accelerator adjustments are discussed. (tr-auth)

**32787** (NP-10801) TRAVELING WAVE PLASMA ACCELERATORS. Publication No. 1856. A. S. Penfold (Liton Systems, Inc., Beverly Hills, Calif.). Oct. 15, 1961. 17p. (TM-61-30)

A review is presented on the operating parameters of traveling wave plasma accelerators as thrust engines and on the current status of experimental programs on these accelerators. A qualitative comparison between the properties of traveling wave plasma accelerators and those of other electric thrust devices is included. (D.L.C.)

**32788** (NP-10823) CROSSED FIELD ACCELERATORS. Emil J. Hellund and Vernon H. Blackman (MHD Research, Inc., Newport Beach, Calif.). [1961]. Contracts NAS 5-1120 and AF33(600)-42621. For Marquardt Corp., Van Nuys, Calif. 18p.

Presented at the American Rocket Society Space Flight Report to the Nation, New York, October 9-15, 1961.

The advantages and disadvantages of linear, steady-state  $\vec{j} \times \vec{B}$  (magnetohydrodynamic) accelerators with rectangular symmetry are outlined. Progress made on this accelerator type is described. A new theoretical approach to magnetohydrodynamic channel flow is presented which is based on kinetic theory. Areas in which research and development are needed are outlined. (D.L.C.)

**32789** (ORN-L-TM-25) THE CYCLOTRON RESONANCE INSTABILITY WITH NEGATIVE MASS IONS. T. K. Fowler and E. G. Harris (Oak Ridge National Lab., Tenn.). Oct. 17, 1961. Contract W-7405-eng-26. 5p.

Both the effect of resonant coupling of ion cyclotron motion to electron plasma oscillations, as previously discussed by Harris, and the effect of a negative radial gradient in a magnetic mirror field, the so-called "negative mass" effect, were combined in an approximate calculation for the threshold for electrostatic instability in DCX. The two mechanisms for instability were found to act more or less independently. (auth)

**32790** (UCRL-9721) BEVATRON OPERATION AND DEVELOPMENT. XXIX. [Period covered] February through April 1961. Walter D. Hartsough (California. Univ., Berkeley. Lawrence Radiation Lab.). June 14, 1961. Contract W-7405-eng-48. 12p.

The Bevatron was operated 84% of the scheduled operating time this quarter. The machine was shut off 12% of the scheduled operating time because of component failure and 4% at the request of the user. Four resident laboratory research groups and six groups from outside institutions conducted experiments in  $\pi^-$  and K-meson beams. Bubble chambers, counter techniques, and spark chambers were used. A program to modernize the Bevatron was approved and is in the early stages of accomplishment. (auth)

**32791** EXTRACTION OF A BEAM AND ENERGY REGULATION IN THE CYCLOTRON WITH AZIMUTHALLY VARYING MAGNETIC FIELD. A. A. Arzumanov, R. A. Metshcherov, E. S. Mironov, L. M. Nemenov, S. N. Ribin, and Yu. A. Kholmovskii (J. A. Kholmovskij) (Kurchatov's Atomic Energy Inst., Academy of Sciences, Moscow). Nuclear Instr. & Methods, 12: 363-4 (July 1961). (In English)

A 1.5 meter cyclotron, with circular windings on the inner side of each cover of the accelerating chamber, was used. Experiments were made at 5, 10, 13.6, 14.7, and 17 kilogauss in the magnetic field. The deflection system consisted of two parts, one inside the dee, the other outside; extraction of the beam was studied when both were functioning simultaneously as well as when the outer part was removed. The coefficient of extraction remained practically constant. The deflecting system as a whole was studied at 5 and 10 kilogauss; the voltage at the inner part leads was 23 kv, and at the outer, 30 kv at 10 kilogauss. Thus the beam was extracted from the accelerating chamber with a small angular divergence which permits the use of the small aperture quadruple lenses producing no loss in the ion beam intensity. (L.N.N.)

**32792** THE CAMBRIDGE ELECTRON ACCELERATOR. This 6-Billion-Volt Machine will be the World's Highest Energy Electron Synchrotron. M. Stanley Livingston and William A. Shurcliff (Massachusetts Inst. of Tech., Cambridge). Science, 134: 1186-93 (Oct. 20, 1961).

The design principles and uses of this 6-Bev electron synchrotron are described. A schematic diagram is presented. The alternating-gradient, injector (25 Mev pre-accelerator), radio-frequency system, vacuum system, and the magnet design are discussed. The laboratory equipment arrangements and types are described. The particle physics of the electron is briefly discussed. (N.W.R.)

**32793** ON THE SELECTION OF CHARACTERISTIC OF THE SEGMENT CYCLOTRON. Yu. Ya. Lembra. Uchenye Zapiski Tartu. Gosudarst. Univ., No. 74, 96-9 (1959).

The most harmful resonances of vertical oscillations in the segment cyclotron can be eliminated if the relation  $\omega_2/\omega < 1/2$  takes place at the beginning of acceleration where  $\omega_2$  is the frequency of vertical oscillations and  $\omega$  is the frequency of ion revolutions. In some cases, when the prescribed course of variation in the phase of vertical oscillations should be assured the condition  $\omega_2/\omega > 1/2$  must be

satisfied at the beginning of acceleration. (Referativnyz, No. 12, 1961).

**32794** IMPROVEMENTS IN OR RELATING TO PARTICLE ACCELERATORS. Jiri Teichman. British Patent 878,812. Oct. 4, 1961.

A small-size cyclotron is designed with means for superimposing on the basic magnetic field helical inhomogeneities transverse to the general orbit plane so that the particles will be focused in their relative orbits. Several embodiments of this means are described. (D.L.C.)

## Plasma Physics and Thermonuclear Processes

**32795** (AFOSR-1026) LINEARIZED OSCILLATIONS IN A PLASMA. Gerald Schubert (Cornell Univ., Ithaca, N. Y. Graduate School of Aeronautical Engineering). Sept. 1961. Contract AF49(638)-544. 88p.

The possible modes of oscillation of a plasma are determined from the linearized equations of the two-fluid model. The linearization is carried out in the presence of a strong steady magnetic field, and only wave propagation normal to the magnetic field is considered. The equations determine the regimes of applicability for the single-fluid equations and the magneto-ionic theory; and both theories are found to be special cases of the general equations. The linearized equations of the single-fluid model are used to investigate the interaction of a low frequency electromagnetic wave with a semi-infinite plasma. Solutions are obtained for both normal incidence and parallel propagation of the electromagnetic wave. In both cases a strong steady magnetic field exists parallel to the interface. It is found that the ratio of the Alfvén velocity to the speed of sound is the parameter that determines the character of the solution. The magneto-ionic theory is found to be a special case of the linearized two-fluid equations. If collisions of identical particles are neglected, the theory of radio wave propagation results. The results of the magneto-ionic theory are characterized by the applied frequency, the electron gyrofrequency, the plasma frequency, the collision frequency of electrons and ions, and the electron-to-ion mass ratio. The dispersion relation yields two types of polarizations for the waves; one of which is unaffected by the presence of the magnetic field. (auth)

**32796** (AFOSR-1332) THEORY OF VISCOUS MAGNETOGASDYNAMIC FLOW IN SLOWLY DIVERGING TWO-DIMENSIONAL CHANNELS. B. U. O. Sonnerup (Cornell Univ., Ithaca, N. Y. Graduate School of Aeronautical Engineering). Sept. 1961. Contract AF49(638)-544. 166p.

A class of viscous magnetogasdynamic flows at moderate Reynolds number in slightly divergent two-dimensional channels is treated theoretically. The conducting walls of the channel serve as electrodes and are connected to an external load so that the device operates as a power generator. The main component of the applied magnetic field is perpendicular to the flow direction but parallel to the channel walls. The flowing medium is a slightly ionized gas with variable fluid properties. In particular two different mathematical models of the electrical conductivity are used. The theory pertains to low values of the magnetic Reynolds number, based on the channel height, and to moderate values of the Hall parameter. Entrance and exit effects are not considered. The equations of fluid dynamics are simplified by approximations similar to those employed in ordinary boundary-layer theory, and the resulting set of



equations is then solved exactly and in closed form for a particular family of pressure variations along the channel. The main parameters appearing in the solution are the viscous Reynolds number, the Mach number, the Hartmann number and a parameter describing the pressure variation along the channel. Numerical examples pertaining to various types of boundary conditions on temperature, wall heat transfer, or potential difference across the channel are presented showing channel shapes, velocity and temperature profiles and efficiency data. (auth)

**32797** (JPL-TR-32-106) PLASMA THEORY OF ELECTRON-PHONON INTERACTION. [PART] II. Oldwig von Roos (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). June 25, 1961. Contract NASw-6. 21p.

The statistical theory recently developed is applied to an investigation of the influence of lattice vibrations on the dielectric properties of an electron gas. It is found that this influence is small at all wave lengths. An investigation is also made of the dispersion relation of sound waves in metals as a function of temperature. The results of Bardeen and Pines for 0°K are rederived, and it is shown that the temperature dependence of the renormalized sound frequencies is mediated solely by the temperature dependence of the Fermi-Dirac distribution of the electrons. (auth)

**32798** (LAMS-2609) PROPOSAL FOR A 3.5-MEGA-JOULE MAGNETIC COMPRESSION EXPERIMENT SCYLLA IV. E. L. Kemp, T. M. Putnam, W. E. Quinn, and F. L. Ribe (Los Alamos Scientific Lab., N. Mex.). Aug. 1, 1961. Contract W-7405-ENG-36. 47p.

The Scylla I experiment demonstrated that by the application of a fast rising sinusoidal axial magnetic field to a volume of partially ionized deuterium gas a small volume of plasma can be produced with an ion temperature (random energy) of 1.3 kev and electron temperature of 0.35 kev. Extensive studies have shown that the attainment of a hot plasma depends upon such phenomena as the initial condition of ionization, the gas density, and the size of the magnetic field which the plasma has in it when the initial cylindrical shock is applied. An increase of capacitor bank energy by a factor of 6, to 180 kjoule, in Scylla III indicates scaling of plasma temperature according to the adiabatic compression relationship and has permitted the study of the effect of coil length on the stability of the plasma. The extrapolation of Scylla to more energetic systems is considered in relation to the Lawson criterion for a net energy-producing, pulsed reactor. The possibility of extrapolating Scylla to the Lawson limit is discussed in relation to the questions of containment and radiation loss. The Scylla parameters at the Lawson limit are given assuming that the compressed states of more energetic devices will extrapolate along an adiabatic compression curve from present experimental conditions. Changing the initial conditions of the experiment by injecting plasma into Scylla is also discussed. Extrapolation of the present experiment to achieve the minimum containment time  $\tau = 500 \mu\text{sec}$ , as well as the  $n$  and  $kT$  values of the Lawson limit, would be premature in view of the present state of experimental knowledge. However, it is feasible, as the next step, to build an experimental apparatus capable of giving approximately the same final plasma density and temperature as in a net energy-producing plasma and a magnetic half period of sufficient length to allow the stability problem to be studied thoroughly. The choice of parameters for such a Scylla system is discussed and its conceptual design is given in terms of the magnetic energy in the coil which can be expected from the various capacitor banks which will be used to energize the coil. The engineering aspects of the design of a 3.5

Mjoule experiment, Scylla IV, are discussed. The basic problems in the design are those of minimizing the energy source inductance, providing electrical insulation for voltages of tens of kilovolts and providing transmission systems and switches for handling currents of 20 to 30 Mamp. The design of the capacitor banks, switches, cable headers and collector plates is described. (auth)

**32799** (NP-10828) CHARGED PARTICLE DYNAMICS AND ELECTROSTATIC POTENTIAL GRADIENTS IN A NEUTRAL PLASMA. J. W. Davis, A. P. Walch, R. G. Meyerand, Jr., and F. Salz (United Aircraft Corp. Research Labs., East Hartford, Conn.). [1961]. 22p.

An analysis was made of the oscillating-electron ion engine to determine the dynamics of the charged particles in a one-dimensional nonuniform plasma. The nature of the momentum exchange between ions and electrons was investigated to ascertain where the reaction force is felt on the engine. The results prescribe a potential distribution for the most efficient ion engine operation, and provide a method for evaluating the maximum attainable efficiency based on the power loss caused by the back-flow of ions in the plasma. (B.O.G.)

**32800** (NP-10850) MAGNETIC FIELD MEASUREMENTS DURING THE FAST MAGNETIC COMPRESSION OF A PREHEATED DEUTERIUM PLASMA AND THEIR RELEVANCE. E. Hintz (Kernforschungsanlage. Institut für Plasmaphysik, Jülich, Germany). Aug. 1961. 32p. (Jül-13-PP).

During experiments on the fast magnetic compression of pre-heated plasmas, reliable magnetic field measurements were attempted. It was concluded that, for the given set of parameters and for times of about one microsecond, probe measurements are reliable. The magnetic flux was constant for the time interval from the first compression up to current maximum. The comparison of oscillation periods with and without probes showed a remarkably good agreement. The magnetic field on the axis agreed within the limits of accuracy of the measurement with the initial magnetic field on the axis multiplied by the compression ratio. It was concluded that a stable high B plasma can be produced reproducibly for the first half period time of the bank with densities of about  $3 \times 10^{17}$  per  $\text{cm}^3$  and a temperature of about  $2 \times 10^6$ °K. (M.C.G.)

**32801** (SIT-P37) INVESTIGATION OF PLASMA ACCELERATION. Final Report, September 10, 1960–May 15, 1961. Includes report SIT-P38: THE CAPTURE OF THERMAL ELECTRONS INTO STABLE BETATRON ORBITS. PART I. K. C. Rogers and G. Schmidt (Stevens Inst. of Tech., Hoboken, N. J.). Contract DA-36-039-SC-78097. 57p. (AD-258430)

Construction of an air-core plasma betatron is described. A method of shaping the magnetic field by eddy currents is described and field measurements are presented. Methods of obtaining low density plasmas suitable for plasma betatrons are described. In addition, work on plasma betatron theory and particle capture into betatron orbits is presented. (auth)

**32802** (UCRL-6131) TRAPPING AND CONFINEMENT OF 20-KEV HYDROGEN ATOMS IN A MAGNETIC MIRROR MACHINE. James F. Steinhaus and Charles C. Damm (California, Univ., Livermore, Lawrence Radiation Lab.). Dec. 1960. Contract W-7405-eng-48. 32p.

A preliminary test was made of some of the principles involved in plasma production by the trapping of energetic atoms. A beam of hydrogen atoms of 20-kev energy and 1.5-ma equivalent intensity was injected diametrically across the midplane of a magnetic mirror machine. The

major trapping mechanism was ionization by impact with residual gas molecules, while the controlling loss process was charge-exchange neutralization of the protons by collision with the gas. The energetic atomic beam was formed by neutralization of a proton beam in a hydrogen gas cell at a measured efficiency of 0.70. The trapped-ion density was estimated from the measured beam intensity by comparison of the ion trapping with loss rates, yielding a value of  $8 \times 10^6$  ions/cm<sup>3</sup>. The Debye length at this density was comparable to the machine dimensions so that essentially single-particle behavior was observed. The characteristic buildup and decay times for the trapped-ion density were measured in the pressure range from  $3 \times 10^{-5}$  mm Hg to  $3 \times 10^{-6}$  mm Hg and agreed with the values predicted from the charge-exchange cross section within experimental uncertainty. The decay times measured were independent of magnetic field intensity, and hence orbit size, within the range from 2.5 to 5 cm orbit diameter. It was concluded that losses due to nonadiabatic particle trajectories are negligible under these conditions. (auth)

**32803** (UCRL-6236) A THEORY OF SCATTERING LOSS FROM A MAGNETIC MIRROR SYSTEM. David J. BenDaniel (California, Univ., Livermore. Lawrence Radiation Lab.). Mar. 7, 1961. Contract W-7405-eng-48. 57p.

The problem of scattering loss of a single ion species from a magnetic mirror system was considered. Using the adiabatic approximation, a reference distribution and a trajectory integral were developed by use of which the time behavior of the distribution function of contained particles everywhere in the system could be found. A four-parameter representation of the magnetic field of mirror machines is discussed. A step approximation to the magnetic field was invoked for spatial integration of the trajectory integral. The collisions were treated by the Rosenbluth form of the Fokker-Planck equation. A spatially invariant approximation to the magnetic mirror system, called the square well, was considered first. The behavior of the angular part of the spatially independent distribution function for this case is shown to be well approximated by the decay of angular modes. The speed distribution of the ions in a spatially invariant system is given by an equation that was next developed. This equation was an approximation to the Rosenbluth equation using effective isotropic potential functions. Comparison of theory and numerical work was made. Systems in which the spatial variation of the magnetic field was taken into account were then studied. The behavior of the reference distribution in angle was theoretically derived from the mode approximation in terms of a matrix of coefficients which represent the nonlinear behavior of the system. The lowest mode appropriate to the over-all ratio was found to be the angular part of the asymptotic reference distribution. A physical explanation of this effect is given. The speed distribution was found to be a property of the mirror ratio alone and not a function of the spatial properties of the system. Numerical results are presented in verification of the theory. Expressions for the asymptotic form of the distribution function in velocity and coordinate space are given. Steady sources were also considered and the effect of the shape of the mirror system pointed out. The relative thermonuclear efficiency, as a function of the shape of the system was defined and calculated for certain systems. (auth)

**32804** (UCRL-6583) ON THE DIFFUSION OF MAGNETIC FIELD INTO A CONDUCTING GAS IN WHICH INERTIAL FORCES ARE NEGLECTED. R. E. Kidder (California, Univ., Livermore. Lawrence Radiation Lab.). Aug. 21, 1961. Contract W-7405-eng-48. 26p

The half-space problem of the diffusion of a magnetic field into an electrically conducting ideal gas (magnetic pressure initially equal to gas pressure) is treated. The assumption of negligible inertial forces reduces the partial differential equations to ordinary differential equations, and these equations were solved for two cases, one with a conductivity proportional to  $1/T$  and one with a constant conductivity. (D.L.C.)

**32805** (AEC-tr-4509) PROBLEMS OF MAGNETO-HYDRODYNAMICS AND PLASMA DYNAMICS. PROCEEDINGS OF THE CONFERENCE ON MAGNETOHYDRODYNAMICS, RIGA, JULY 2-10, 1958. Translation of Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958 (1959). 295p.

Fifty six papers were presented at the conference. The proceedings include 37 full-length papers, 19 abstracts of papers, and several discussions of the papers. Separate abstracts have been prepared for 51 of the 56 papers included in the proceedings. Four of the papers have been previously abstracted in NSA. Only one of the papers is not abstracted separately; this paper covers some applications of induction pumps in the casting and metallurgy industry. (T.F.H.)

**32806** (AEC-tr-4509(p.1-4)) ROLE OF MAGNETO-HYDRODYNAMICS AND PLASMA DYNAMICS IN CERTAIN PROBLEMS OF ASTROPHYSICS. D. A. Frank-Kamenetskii. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 7-11(1959).

Methods of magnetohydrodynamics (MHD) are applied to several problems of astrophysics, namely: the origin of cosmic magnetic fields; the effect of the magnetic field on the stability of stellar motion; the effect of turbulent magnetic fields on stellar shock waves; and the role of MHD phenomena in processes of plasma heating and particle acceleration. (T.F.H.)

**32807** (AEC-tr-4509(p.5-32)) MAGNETOHYDRODYNAMICS AND THE INVESTIGATION OF THE VARIATIONS OF COSMIC RAYS. L. I. Dorman. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 13-44(1959).

All observed types of cosmic ray variations are discussed. Interpretations of these variations in terms of solar and galactic magnetohydrodynamic characteristics are given. (T.F.H.)

**32808** (AEC-tr-4509(p.33-6)) SPECTRUM OF COSMIC RAYS AND THEIR ROLE IN COSMIC GAS DYNAMICS. S. I. Syrovatskii. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 45-8(1959).

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 16284.

**32809** (AEC-tr-4509(p.37-45)) INFLUENCE OF A MAGNETIC FIELD ON THE STABILITY OF FLOW OF A CONDUCTING LIQUID. E. P. Velikhov. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 49-58(1959).

Magnetic field effects on the stability of various types of liquid flow (plane, cylindrical, etc.) are found, for various combinations of the liquid's viscosity, conductivity, etc. Only stationary flows are considered. It is concluded that a dynamically unstable system can generally be stabilized by a suitable magnetic field. (T.F.H.)

**32810** (AEC-tr-4509(p.46-9)) CERTAIN PROBLEMS IN THE MOTION OF A RAREFIED PLASMA IN A MAG-



NETIC FIELD. Ya. P. Terletskii. Translated from *Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy*, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 59-62(1959).

In determining the magnetohydrodynamic characteristics of a system containing a conducting liquid, the concept that the liquid is "tied" to the lines of force may be used. This concept is applied, as an approximation, to two special cases of rarefied plasma flow in a magnetic field. It is found that the approximation is in agreement with the results of plasma dynamic calculations. (T.F.H.)

**32811** (AEC-tr-4509(p.50-2)) NONLINEAR STEADY MOTION OF RAREFIED PLASMA IN A MAGNETIC FIELD. R. Z. Sagdeev. Translated from *Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy*, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 63-5(1959).

It is proposed that shock waves may exist in a rarefied, nearly collisionless plasma. Collisions, which are rare, cannot provide the damping necessary for the existence of a shock wave with an oscillator front structure. An alternative damping mechanism is hypothesized that depends on phase mixing, which is caused by inhomogeneities in the magnetic field. (T.F.H.)

**32812** (AEC-tr-4509(p.59-62)) REGARDING ACCELERATION OF PLASMA IN A MAGNETIC FIELD. L. V. Gordeev and A. I. Gubanov. Translated from *Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy*, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 73(1959).

The steady-state motion of a plasma between two coaxial cylindrical electrodes in an external axial magnetic field (B) is studied, in the hydrodynamic approximation. The velocity of rotation of the plasma is found as a function of B, the plasma current, and the electrode radii. The heat conductivity and viscosity are found as functions of the temperature. The stability, relaxation time, and other properties of the plasma are calculated. (T.F.H.)

**32813** (AEC-tr-4509(p.63-7)) ON THE POSSIBILITY OF ACCELERATING CHARGED PARTICLES BY MEANS OF SHOCK WAVES IN A MAGNETIZED PLASMA. L. I. Dorman and G. I. Friedman. Translated from *Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy*, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 77-81(1959).

A mechanism is proposed to explain the acceleration of particles during solar flares, magnetic storms, etc. It is hypothesized that shock waves, formed in the sun, the solar corona, the interplanetary and an interstellar media, the shells of novae and supernovae, etc., can accelerate particles to energies up to ~100 Mev by this mechanism. The mechanism utilizes the passage of a shock wave through a plasma having a frozen-in magnetic field. (T.F.H.)

**32814** (AEC-tr-4509(p.68-73)) ON THE ACCELERATION OF CHARGED PARTICLES DURING POWERFUL PULSED DISCHARGES AND COLLISIONS OF MAGNETIZED CLOUDS. L. I. Dorman. Translated from *Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy*, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 83-8(1959).

A mechanism is described by which slow charged particles may be accelerated up to about 100 Mev, during pulsed electric discharges or the convergence and/or collision of two magnetized clouds. The particle is successively reflected between various regions of the field in the discharge, or reflected between the two clouds, with an energy jump during each reflection. The mechanism may be used to describe cosmic phenomena. The accelerated particles may be further accelerated by other mechanisms. (T.F.H.)

**32815** (AEC-tr-4509(p.74-7)) INFLUENCE OF LONGITUDINAL MAGNETIC FIELDS ON THE TEMPERATURE

OF ELECTRONS IN A PLASMA. M. V. Konyukov. Translated from *Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy*, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 89-92(1959).

A positive-column plasma is considered in a longitudinal magnetic field. In this type of plasma, heat losses are caused by heat and glow conduction to the neutral gas. The presence of the field decreases the heat losses by two mechanisms: it reduces the diffusion flux to the walls; and it reduces the heat conduction away from the plasma by the electrons. This latter effect comes about because the field decreases the electron temperature and the potential gradient. (T.F.H.)

**32816** (AEC-tr-4509(p.78-89)) INVESTIGATION OF CERTAIN CHARACTERISTICS OF ZENON AND ARGON PLASMA BEHIND A POWERFUL SHOCK WAVE. S. R. Kholev. Translated from *Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy*, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 93-105(1959).

The spectra of ionized H<sub>2</sub>, O<sub>2</sub>, Ar, and Xe behind a shock wave are measured as functions of the shock temperature. It is found that the measured spectra are comparable to the black-body radiation from the sun. At a shock temperature of 12300°K, Ar yields a line spectrum and Xe yields a continuous spectrum. The spectral differences between these two gases are interpreted in terms of the densities and degrees of ionization of the gases. (T.F.H.)

**32817** (AEC-tr-4509(p.90-7)) OBSERVATIONS OF AN ELECTROMAGNETICALLY PINCHED ARC WITH THE AID OF AN ELECTRON-OPTICAL CONVERTER. B. L. Granovskii, K. P. Ryumina, V. I. Savoskin, and G. G. Timofeeva. Translated from *Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy*, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 107-15(1959).

Pinch discharges in Hg and H at 10<sup>-3</sup> to 10<sup>-2</sup> mm Hg are observed as functions of the discharge current (i) and di/dt. Current pulses of about 300 μsec pass through the gases. It is found that the pinch persists in some cases during negative values of di/dt. (T.F.H.)

**32818** (AEC-tr-4509(p.98-9)) STABILITY OF SHOCK WAVES IN MAGNETOHYDRODYNAMICS. A. I. Akhiezer, G. Ya. Lyubarskii, and R. V. Polovin. Translated from *Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy*, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 116(1959).

Original published in *Zhur. Eksptl'. i Teoret. Fiz.*, 35: 731(1958).

The mechanical stability of shock waves in magnetohydrodynamics (MHD) is studied, under one-dimensional perturbations. It is shown that it is possible to have a type of instability that causes the shock wave to split up into several waves. The waves stable against splitting are of three types: fast magnetoacoustic; slow magnetoacoustic; and magnetohydrodynamic. Because of the existence of these three types of waves, it is possible to have a case in MHD in which as many as three shock waves or weak discontinuities move in the same direction. (T.F.H.)

**32819** (AEC-tr-4509(p.100-7)) INTERACTION BETWEEN SMALL PERTURBATIONS AND DISCONTINUITIES, AND STABILITY OF SHOCK WAVES IN MAGNETOHYDRODYNAMICS. V. M. Kontorovich. Translated from *Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy*, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 117-25(1959).

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 13, abstract no. 4899.

**32820** (AEC-tr-4509(p.108-12)) ON THE STABILITY OF SHOCK WAVES IN MAGNETOHYDRODYNAMICS. S. I.

Syrovatskii. Translated from *Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy*, Trudy Konf. Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 127-31 (1959).

The interaction of an oblique stationary shock wave with a weak magnetohydrodynamic wave in a magnetohydrodynamic medium is studied in the two-dimensional case. In particular, the case of a  $180^\circ$  collision between these two waves is considered. The general solution allows the original MHD wave to be split into three waves, one reflected from the shock front and two transmitted through it. It is shown from physical considerations, however, that the production of three waves is impossible. Conditions are discussed under which only two waves—one reflected and one transmitted, or two transmitted—may be produced. The production of a single wave is shown to disrupt the stationary flow of the medium. (T.F.H.)

**32821** (AEC-tr-4509 (p.113)) IMPOSSIBILITY OF RAREFACTION SHOCK WAVES IN MAGNETOHYDRODYNAMICS. R. V. Polovin and G. Ya. Lyubarskii. Translated from *Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy*, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 132 (1959).

Original published in *Zhur. Eksptl'. i Teoret. Fiz.*, 35: 510 (1958).

Zemlen's theorem is generalized to the case of magnetohydrodynamics. In ordinary hydrodynamics, i.e. when the magnetic intensity  $H = 0$ , the shock adiabat lies below the constant-entropy line. For  $H \neq 0$ , the shock adiabat lies even lower, under the conditions  $(\partial^2 V / \partial p^2)_S > 0$  and  $(\partial p / \partial T)_V > 0$ . (auth)

**32822** (AEC-tr-4509 (p.114)) ZEMPLEN'S THEOREMS IN MAGNETOHYDRODYNAMICS. S. V. Iordanskii. Translated from *Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy*, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 133 (1959).

Original published in *Doklady Akad. Nauk S.S.S.R.*, 121: 610 (1958).

Zemlen's theorem is proved in magnetohydrodynamics for arbitrary discontinuity amplitudes, assuming  $(\partial^2 p / \partial V^2)_S > 0$  and  $(\partial p / \partial S)_V > 0$ , where  $S$  is the entropy. The proof is carried out as in gas dynamics. The following cases are considered:  $H_n \neq 0$ ,  $H_t \neq 0$ ; and  $H_n \neq 0$ ,  $H_t = 0$ ,  $H_2 \neq 0$ .  $H_n$  is the magnetic intensity normal to the discontinuity surface, and  $H_t$  and  $H_2$  are tangential components in front of and behind the surface, respectively. The proof for the remaining cases is trivial. (auth)

**32823** (AEC-tr-4509 (p.115)) OBLIQUE SHOCK WAVE IN A PLASMA WITH FINITE CONDUCTIVITY AND SEVERAL OTHER PROBLEMS IN THE THEORY OF SHOCK WAVES. M. I. Kiselev and V. I. Tseplyaev. Translated from *Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy*, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 135 (1959).

Original published in *Zhur. Eksptl'. i Teoret. Fiz.*, 34: 1605 (1958).

Consideration is given to boundary conditions and wave front structures, for an oblique shock wave in a plasma with finite conductivity. Conditions are given under which kinematic viscosity and heat conduction can be neglected as compared with magnetic viscosity. The velocity of the gas ahead of the front is chosen to be greater than the accelerated velocity of sound ( $U_+$ ). A family of branches of shock polars corresponding to values of  $U_+$  is obtained for an ideally conducting plasma. The limiting angle of rotation of the front of the shock wave is calculated for a particular case. An investigation is also made of a straight shock wave in a plasma with finite conductivity. An esti-

mate is made of the width of the transition layer in the ultrarelativistic approximation. Exact relations cannot be obtained for the front structure in the relativistic case. (auth)

**32824** (AEC-tr-4509 (p.116)) ON THERMODYNAMIC EQUILIBRIUM OF THE SURFACES OF A STRONG DISCONTINUITY. V. I. Skobel'kin. Translated from *Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy*, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 136 (1959).

Original Published in *Doklady Akad. Nauk S.S.S.R.*, 122: 431 (1958).

A study is made of the general case of motion of gas in the presence of a shock wave or a sharply defined reaction front, in which the wave or front separates the burning gas from the original gas. Conditions are shown under which the subsonic steady flow of a perfect gas satisfies the variational equation. The subsonic flow of a perfect gas is considered, as an example, in a tube in the presence of a flame front that propagates with a known velocity. (auth)

**32825** (AEC-tr-4509 (p.117-20)) REGARDING THE EXCITATION OF HYDROMAGNETIC WAVES. A. I. Akhiezer and A. G. Sitenko. Translated from *Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy*, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 137-40 (1959).

The excitation of magnetoacoustic, hydromagnetic, and electromagnetic waves in a plasma by the action of an external current is discussed. Consideration is given to the cases in which the external current frequency ( $f_{ex}$ ) is much greater or much smaller than the electron cyclotron frequency ( $f_c$ ), and in which  $f_{ex}$  is on the same order of magnitude as  $f_c$ . (T.F.H.)

**32826** (AEC-tr-4509 (p.121)) CHERENKOV GENERATION OF MAGNETOACOUSTIC WAVES. A. I. Morozov. Translated from *Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy*, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 141 (1959).

Original published in *Fiz. Plazmy i Problema Upravlyayemykh Termoyader. Reaktsii*, 4: 330 (1958).

The generation of magnetoacoustic waves by a current-carrying loop (or filament), moving with velocity  $V$  along the external magnetic field  $B$  such that the plane (or length) is perpendicular to  $B$ , is studied in an ideally conducting medium. The filament is assumed to move near the surface of the medium. The linearized equations of magnetohydrodynamics lead to the radiation conditions that decelerated waves are radiated if  $C_0 < V < \min(C_t, V_a)$  and that accelerated waves are radiated in  $V > \max(C_t, V_a)$ , where  $C_t$  is the velocity of sound,  $V_a$  is the Alfvén velocity, and  $C_0^2 = (C_t^2 \cdot V_a^2) / (C_t^2 + V_a^2)$ . The radiation power from the medium-loop and medium-filament interactions is found for an infinite homogeneous medium. For a medium with a separation boundary, the radiation losses are determined for the motion of the filament along the boundary. The losses are also determined for the motion of a loop along a plasma column. The order of magnitude of the time necessary for the plasma velocity to become comparable to  $V$  is determined. The plasma velocity change is assumed to result from momentum transfer to the plasma from the radiation, and the time estimate is based on the time during which the energy of the excited waves is comparable to the thermal energy of the plasma prior to the radiation. (auth)

**32827** (AEC-tr-4509 (p.126-8)) ON THE DAMPING OF MAGNETOHYDRODYNAMIC WAVES IN A PLASMA. R. Z. Sagdeev. Translated from *Voprosy Magnit. Gidrodinamiki*



i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 147-9 (1959).

A plasma is considered whose ions have a Larmor radius  $r_H$  that is much smaller than their mean free path  $l$ . It is shown that relaxation effects in such a plasma increase the damping of magnetohydrodynamic waves by a factor of  $(l/r_H)^2$  over the damping caused by viscosity and heat conduction effects alone. The case of a plane transverse magnetoacoustic wave is considered as an example. (T.F.H.)

**32828** (AEC-tr-4509 (p.129-35)) SIMPLE WAVES IN MAGNETOHYDRODYNAMICS. A. I. Akhiezer, G. Ya. Lyubarskii, and R. V. Polovin. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga 1958, 151-7 (1959).

The properties of simple one-dimensional waves in magnetohydrodynamic media are studied. Particular attention is given to magnetohydrodynamic Alfvén waves, magnetoacoustic waves, and entropy waves. The hydrodynamic equations for a linear combination of any number of these simple waves are given. It is shown that, in the absence of shock waves, a region of constant flow in a magnetohydrodynamic medium can bound only on a simple wave. (T.F.H.)

**32829** (AEC-tr-4509 (p.136)) SIMPLE MAGNETO-ACOUSTIC WAVES. G. Ya. Lyubarskii and R. V. Polovin. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 158 (1959).

Original published in Zhur. Eksptl'. i Teoret. Fiz., 35: 509 (1958).

It is shown that, as in ordinary hydrodynamics, the phase velocity of a simple magnetoacoustic wave increases with increasing density ( $\rho$ ), if the inequality  $(\partial^2[\rho - 1]/\partial \rho^2)_{\rho} > 0$  is satisfied. This result is used for a qualitative investigation of the time variation of a simple wave. Conditions obtained for the occurrence of a discontinuity agree with known criteria. (auth)

**32830** (AEC-tr-4509 (p.137)) RIEMANN WAVES IN MAGNETOHYDRODYNAMICS. A. G. Kulikovskii. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 159 (1959).

Original published in Doklady Akad. Nauk S.S.S.R., 121: 957 (1958).

Consideration is given to one-dimensional isentropic motions of a perfect gas, caused by plane waves in the presence of a magnetic field. The velocities and the magnetic field are assumed to lie in the same plane. A solution is sought in the form of traveling Riemann waves. It is shown that there exist two types of waves, for each of which the solution reduces to integration of one differential equation of first order. These equations are solved qualitatively. In the case of weak magnetic fields, the solutions are obtained in quadrature form. The derivatives of the velocities of wave motions over the plane are calculated for both types of waves, and it is found that these derivatives are non-negative, i.e. that both types of waves tend to become compressive shock waves. (auth)

**32831** (AEC-tr-4509 (p.138-42)) PLANE PROBLEMS OF MAGNETOHYDRODYNAMICS. G. S. Golitsyn. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 161-5 (1959).

The flow of an ideally conducting fluid over a plane is considered, with a magnetic field  $B$  perpendicular to the plane. It is found that if the energy of the magnetic field

is much greater than the internal energy of the fluid, a solution can be found for the motion, in any case for which a solution can be found in ordinary hydrodynamics (i.e., for  $B = 0$ ). (T.F.H.)

**32832** (AEC-tr-4509 (p.143-7)) ON FLOWS PRODUCED BY WAVES IN MAGNETOHYDRODYNAMICS. A. I. Ivanovskii. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 167-71 (1959).

Waves in magnetohydrodynamic (MHD) media are classed as three types: transverse MHD waves; slow magnetoacoustic waves; and fast magnetoacoustic waves. It is shown that any of these types of waves may cause a net flow of matter. (T.F.H.)

**32833** (AEC-tr-4509 (p.148)) UNSTEADY SELF-SIMILAR MOTIONS OF GAS IN A MAGNETIC FIELD. V. N. Korobeinikov. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 173 (1959).

Original published in Doklady Akad. Nauk S.S.S.R., 121: 613 (1958).

A study is made of one-dimensional self-consistent adiabatic motion, caused by cylindrical and plane waves in the presence of a magnetic field, of a perfect electrically conducting gas. Viscosity and heat conduction effects are ignored. Several specific problems are considered, for flows caused by plane waves in a medium with infinite conductivity and a magnetic field parallel to the wave fronts. The first case considered is that in which the specified initial discontinuity gives rise to two shock waves and a tangential discontinuity (such as occurs when two masses of conducting gas move toward each other in vacuum, with their velocities perpendicular to the magnetic field). An estimate is obtained for the possible values of the difference between the initial velocities. The second case considered is that in which the plane shock wave propagates at a constant velocity in a gas that is at rest, and is reflected from a solid wall. The magnetohydrodynamic characteristics of the gas behind the reflected wave are determined. The third case considered is that in which a flat tube that unbanded at one end and closed with a piston at the other end contains a gas that is set into motion by the piston. The motion of the gas is determined for a constant piston speed. (auth)

**32834** (AEC-tr-4509 (p.149-57)) OSCILLATIONS OF AN INFINITE GAS CYLINDER WITH INTRINSIC GRAVITATION IN A MAGNETIC FIELD. I. M. Yavorskaya. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 175-83 (1959).

Unsteady, continuous, adiabatic motion of a gas cylinder with gravitational interactions is considered; the gas is assumed to be perfectly electrically-conducting, non-heat-conducting, and non-viscous. For an internal magnetic field ( $B$ ) parallel to the cylinder axis, it is found that the gas may either execute compression-expansion oscillations, or it may be compressed steadily toward the axis. It is impossible for the gas to be scattered completely away from the axis. For a  $B$ -field comprised of closed concentric circles, it is found that the gas may be completely scattered away from the axis, against the force of gravitation. (T.F.H.)

**32835** (AEC-tr-4509 (p.158-63)) MAGNETIC BOUNDARY LAYERS AND DISCHARGES OF ELECTRIC CURRENT IN MOVING MEDIA. V. N. Zhigulev. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy

Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 185-90 (1959).

The equations of magnetohydrodynamics are derived, using a vector potential for the magnetic field. A physical insight into the existence of two types of magnetic boundary layers, which occur in conducting liquids at high magnetic Reynolds numbers, is presented. Equations and self-consistent solutions for these types of boundary layers are found. The special case is considered in which two electrodes, one forming the axis and the other forming half of the surface of a cylinder, have current carried between them by a flowing, conducting liquid. (T.F.H.)

**32836** (AEC-tr-4509 (p.164-71)) INVESTIGATION OF THE SYSTEMS OF EQUATIONS OF A CONDUCTING LIQUID IN THE TWO-PARAMETER STATIONARY CASE. V. S. Tkalic. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 191-8 (1959).

Systems of equations are derived, using an arbitrary orthogonal system of coordinates ( $q_1, q_2, q_3$ ), to describe two-parametric stationary motions of a conducting incompressible liquid. The derived equations are compared with the equations of magnetohydrodynamics. By means of the derived equations, the hydrodynamic approximation for a two-component plasma is found. (T.F.H.)

**32837** (AEC-tr-4509 (p.173-84)) SIMILARITY METHODS AND PHYSICAL MODELING IN THE INVESTIGATION OF ELECTROMAGNETIC PROCESSES IN LIQUID METALS. I. M. Kirko. Translated from Voprosy Magnit. Gidrodinamiki i Dinimiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 201-10 (1959).

Criteria are described for interpreting physical modeling experiments (i.e., experiments performed under modified scales), for magnetohydrodynamic phenomena in liquid metals. The method utilizes both hydromagnetic and heat transfer equations. (T.F.H.)

**32838** (AEC-tr-4509 (p.185-91)) MODEL OF AN INFINITELY LONG CHANNEL WITH LIQUID METAL CONTAINED IN A RUNNING MAGNETIC FIELD. I. M. Kirko, Ya. Ya. Klyavin', I. A. Tyutin, and L. Ya. Ul'manis. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 214-20 (1959).

Original published in Nauch. Doklady Vyshei Shkoly, Energet., No. 3, 203 (1958).

A model of an infinite channel is described, composed of a slit between two coaxial cylinders. Assuming the axis of the cylinders to be the  $x$  axis, a magnetic field of  $B_0 \cos(a - bx)$  is applied in the slit where  $a$  and  $b$  are constants. The purpose of this model is to study the flow of liquid metals under the influence of running magnetic fields, such as are found in induction pumps. Liquid Hg is used in the channel as the flowing metal. The pressure loss and flow rate are measured. It is found that the hydraulic pressure losses in the channel of the induction pump can be calculated accurately by means of ordinary turbulent-flow hydrodynamic formulas. (T.F.H.)

**32839** (AEC-tr-4509 (p.192-7)) PRINCIPLE OF MODELING OF THE ELECTRIC FIELD OF ELECTROMAGNETIC PUMPS IN AN ELECTROLYTIC TROUGH AND ON ELECTRICALLY-CONDUCTING PAPER. L. V. Nitetskii. Translated from Voprosy Magnit. Gidrodinamiki i Dinimiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 221-5 (1959).

A method is described for predicting the characteristics of electromagnetic pumps and other induction devices. The method combines analytical calculations and physical

modeling of the system under study. Two models are discussed: one, an electrolytic trough, is used to investigate the electric field of an induction pump; the other is made of electrically-conducting paper, and is used in an analysis of the field of a d-c pump. (T.F.H.)

**32840** (AEC-tr-4509 (p.198-9)) MOTION OF A SPHERE IN A VISCOUS CONDUCTING LIQUID LOCATED IN A LONGITUDINAL MAGNETIC FIELD. A. K. Gailitis. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 227-8 (1959).

Original published in Trudy Inst. Fiz., Akad. Nauk Latv. S.S.R., 11.

A study is made of the stationary flow of a conducting viscous incompressible liquid, with conductivity  $\sigma$  and dynamic viscosity  $\eta$ , over a non-magnetic sphere with radius  $A$  in a longitudinal external magnetic field of intensity  $H$ . The problem is solved for the case of slow motion at low Reynolds' number. The solution is expressed in series form, of which the first three terms are determined. The force  $F$  acting on the sphere is found to be  $F = F_0(1 + 3\bar{B}/4 + 7\bar{B}^2/240 + \dots)$ , where  $\bar{B} = |H|A\sqrt{\sigma}/2c\sqrt{\eta}$ ,  $F_0 = 6\pi\eta A v_\infty$ , and  $v_\infty$  is the unperturbed velocity of the liquid. (auth)

**32841** (AEC-tr-4509 (p.200)) ROTATION OF A CONDUCTING VISCOUS LIQUID IN THE PRESENCE OF A MAGNETIC FIELD. Yu. K. Krumin'. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 229 (1959).

Original published in Latvijas PSR Zinatnu Akad. Vestis, No. 2, 97 (1958).

The moment of resistance ( $L$ ) of a conducting sphere to rotation is calculated. The sphere, with conductivity  $\sigma_1$  and radius  $\rho$ , rotates in a liquid with conductivity  $\sigma$  and viscosity  $\eta$  with a constant angular velocity  $\omega$ . The entire system is placed in a magnetic field of induction  $B$  parallel to the sphere's axis of rotation. The problem is solved by the method of successive approximations. It is shown that  $L$  depends on  $\bar{B}$ ,  $\bar{B}_1$ , and  $\bar{\sigma}$ , where  $\bar{B} = \rho B\sqrt{\sigma}/c\sqrt{\eta}$ ,  $\bar{B}_1 = \rho B\sqrt{\sigma_1}/c\sqrt{\eta}$ , and  $\bar{\sigma} = 2\sigma_1/(2\sigma_1 + 3\sigma)$ . This dependence is shown to be  $L = L_0[1 + \bar{B}^2/15(1 + \bar{B}) + \pi\bar{B}_1(1 - \bar{\sigma})/120]$ , where  $L_0 = 8\pi\eta\omega\rho^3 = L$  for  $B = 0$ . (auth)

**32842** (AEC-tr-4509 (p.201)) STABILITY OF CONVECTIVE MOTION OF AN ELECTRICALLY-CONDUCTING LIQUID BETWEEN PARALLEL PLANES IN A MAGNETIC FIELD. G. Z. Gershuni and E. M. Zhukhovitskii. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 230 (1959).

Original published in Zhur. Eksptl. i Teoret. Fiz., 34: 670; 675 (1958).

Stagnant convection in an electrically conducting liquid in the space between two parallel planes at different temperatures is considered, in the presence of a magnetic field. The convective heat flow is calculated. The effect of the magnetic field on the stability of the convective flow is investigated, for the case in which the parallel planes are vertical. Solutions for the convective flow equations are approximated, for various perturbation amplitudes. The cases of transverse (to the plane) and longitudinal magnetic fields are considered separately. The magnetic field is found to increase considerably the stability of the stationary motion. For both transverse and longitudinal fields, the instabilities caused by both traveling and standing perturbations are considered. The critical Grashoff number and the critical wave number are calculated as



functions of the field, for both types of perturbations considered. (auth)

**32843** (AEC-tr-4509(p.202)) THEORY OF CERTAIN MAGNETODYNAMIC PHENOMENA OF FREE THERMAL LAMINAR CONVECTION OF AN ELECTRICALLY-CONDUCTING LIQUID IN A VERTICAL ROUND TUBE IN A WEAK MAGNETIC FIELD. A. G. Smirnov. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 231(1959).

The effect of a transverse magnetic field (B) on the free thermal laminar convective motion of an electrically conducting liquid is examined. It is assumed that B is so weak that it does not appreciably distort the hydrodynamics of the flow (i.e., B is so weak as to be considered a perturbation). Two cases are considered theoretically: that in which B is perpendicular to the boundary between the rising and descending convective streams; and that in which B is parallel to this boundary. For both orientations of B, the current distribution in the liquid, the "effective viscosity," and the variation of the vertical temperature gradient at which laminar convection occurs are considered. The theoretical results are compared with experimental data on Hg. (auth)

**32844** (AEC-tr-4509(p.203-6)) EXPERIMENTAL INVESTIGATION OF MAGNETOHYDRODYNAMIC PHENOMENA IN THE DAMPING OF OSCILLATING MOTION OF MERCURY IN A TUBE. A. G. Smirnov and N. S. Kozhanova. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 233-5(1959).

The damping of oscillations of Hg in a U-tube by a transverse magnetic field B is studied. The logarithmic damping decrements  $\delta_B$  and  $\delta_0$  are measured as functions of time, in the presence and in the absence of B, respectively. It is found that  $\delta_0$  is composed of two parts; one part ( $\delta_{01}$ ) corresponds to damping of oscillations of the entire Hg column, and the other part ( $\delta_{02}$ ) corresponds to damping of very small meniscus oscillations. The presence of B completely stops the meniscus oscillations. It is found that  $\delta_B - \delta_{01}$  is proportional to  $M^2$ , where M is the Hartmann number. (T.F.H.)

**32845** (AEC-tr-4509(p.207)) BEHAVIOR OF COLLOIDAL FERROMAGNETIC PARTICLES IN AN INHOMOGENEOUS MAGNETIC FIELD. N. I. Eremin. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 237(1959).

The settling process of ferromagnetic colloidal powder is considered in an investigation of the surfaces of the magnetic structure in ferromagnets. It is assumed that in the presence of a complex structure of magnetic charges on the surfaces of the particles, the powder pattern may not coincide with the actual magnetic charge distribution, because the stronger field may capture particles away from the weaker field. This harmful effect is exerted to a lesser degree on like particles. Because of their mutual attraction, however, these like particles can form different complicated groups of particles. The conditions for the passage of these groups of particles through the magnetic field of the surface charges during the settling process are very complicated. Consideration is given to the path covered by the particle during the settling time; the effect of adhesion of particles into complexes on this path; and the effect of surface electric charges. (auth)

**32846** (AEC-tr-4509(p.208-14)) INVESTIGATION OF MAGNETIC FIELDS AND ELECTROMAGNETIC PROC-

ESSES IN LINEAR INDUCTION PUMPS. A. I. Vol'dek. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 239-46(1959).

The magnetic flux losses through the ends of the inductor of a linear induction pump are studied, and methods for their reduction are given. For the case of a flat pump, the effects of transverse edge losses are also studied. (T.F.H.)

**32847** (AEC-tr-4509(p.215-20)) CHOICE OF MAIN PARAMETERS OF INDUCTION PUMPS DESIGNED FOR MAXIMUM EFFICIENCY. E. K. Yankop. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 247-50(1959).

A method is given for optimizing the gap width, pole pitch, inductor frequency, and other design parameters of an induction pump, for a given output requirement. The results are compared with data from a linear flat pump, a cylindrical pump, and a screw-type pump. (T.F.H.)

**32848** (AEC-tr-4509(p.221-7)) OPTIMUM USE OF CONSTRUCTION OF INDUCTION PUMPS. L. G. Savvin. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 253-60(1959).

The efficiency and weight of an induction pump are found as functions of the slip, channel width, pole pitch, pump output, etc. A method is given for optimizing the weight and efficiency requirements. (T.F.H.)

**32849** (AEC-tr-4509(p.228-35)) EXPERIENCE IN DEVELOPING ELECTROMAGNETIC PUMPS AT THE INSTITUTE OF PHYSICS OF THE ACADEMY OF SCIENCES OF THE LATVIAN SSR. P. G. Kirillov, Ya. Ya. Lielpeteris, A. E. Mikel'son, and G. A. Okunev. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 262-8(1959).

Several electrical, magnetic, and hydrodynamic approximations are described that may be used in the design of electromagnetic pumps of the induction and conduction types. The characteristics of plane-linear, helical, and direct-current pumps constructed using these approximations are outlined. Pump cooling methods are discussed. (T.F.H.)

**32850** (AEC-tr-4509(p.237-41)) CONCERNING CERTAIN PROBLEMS IN THE DESIGN OF LINEAR INDUCTION PUMPS. A. I. Vol'dek. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 273-7(1959).

For a linear induction pump having specified pressure, rating, liquid metal speed, electric load, throat thickness, heat insulation, and inductor frequency, a method is presented for optimizing the pole pitch, slip, active length, and throat dimensions. (T.F.H.)

**32851** (AEC-tr-4509(p.242-55)) THE PROBLEM OF THE "ELECTROMAGNETIC CRUCIBLE." R. P. Zhezherin. Translated from Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 279-94(1959).

The use of a high-frequency magnetic field configuration ("crucible" field) to hold a mass of molten metal away from contact with any material object is investigated. Instabilities may occur that allow the metal to flow out of the "crucible" field configuration in which it is trapped. Methods are discussed for reducing these instabilities. Use of the "crucible" field for heating the trapped metal is examined. (T.F.H.)

**32852** (AEC-tr-4509(p.256-62)) A TURBULENT FLOW OF LIQUID METAL UNDER THE INFLUENCE OF A TRAVELING MAGNETIC FIELD. I. M. Kirko and O. A. Lielausis. Translated from *Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy*, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 295-302(1959).

The mixing of a liquid metal by a rotating magnetic field is considered in the case in which the dimensions of the mixing vessel are less than or equal to the penetration depth of the electromagnetic process into the liquid metal. The pressure and velocity of the rotating metal are measured. The frictional force between the metal and the vessel walls is also measured. All the flows considered are turbulent. (T.F.H.)

**32853** (AEC-tr-4509(p.263)) ON THE MIXING OF MOLTEN METALS BY A TRAVELING MAGNETIC FIELD. G. A. Ostroumov. Translated from *Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy*, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 303(1959).

Original published in *Stal*, 11: 999(1958).

An analytical study is made of the technique of mixing molten metals by means of a traveling or rotating magnetic field. Fifty-cycle current is found to be adequate to supply the stator that excites the magnetic field. It is found that the attainment of a turbulent mode becomes simpler and easier as the physical size of the mixing structure increases. Data are obtained for a layer of molten metal extending infinitely in the horizontal directions. The finite extent of the bath increases only slightly the power required by the stator supply to achieve turbulence. (auth)

**32854** (AEC-tr-4509(p.264-9)) USE OF STRAY-FIELD PUMPS FOR MIXING OF LIQUID METALS. A. E. Mikel'son. Translated from *Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy*, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 305-11(1959).

A method of mixing molten metals is presented that utilizes an electromagnet whose pole faces are parallel. The magnet is fed by a-c, and the pole faces are inserted into the region of the molten metal. The alternating field causes the metal between the faces to be forced away from the magnet. (T.F.H.)

**32855** (AEC-tr-4509(p.270-6)) CONSTRUCTION OF A YOKE STATOR FOR INDUCTION MIXING OF METALS IN ARC FURNACES. M. G. Rezin. Translated from *Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy*, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 313-21(1959).

Design considerations for a metal-mixing yoke stator are discussed. The mixing parameters (yoke length, number of poles, number of phases, etc.) are examined. The major structural elements of the stator (core, winding, shape, heat-insulation plates, cooling system, and fastening considerations) are investigated. (T.F.H.)

**32856** (AEC-tr-4509(p.277-85)) POWER SUPPLIES FOR APPARATUS FOR ELECTROMAGNETIC MIXING OF METALS IN ELECTRIC ARC FURNACES. Ya. I. Drobinin. Translated from *Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy*, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 323-33(1959).

The yoke stator used in electromagnetic mixing of metals uses two-phase low-frequency (0.5 to 2 cps) current. Difficulties encountered in using a dynamoelectric system as a power supply for the yoke stator are described. A simplified power supply is shown that utilizes an ionic frequency converter. The simplified system uses no large rotating machinery. (T.F.H.)

**32857** (AEC-tr-4509(p.286)) YOKE MIXERS FOR LIQUID METALS. P. A. Fridkin. Translated from *Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy*, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 335(1959).

The yoke stator of a liquid-metal-mixing system is fed with a 50-cycle current. The necessary speed of the liquid metal is adjusted by regulating the voltage fed to the terminals of the stator, thus regulating the radial magnetic induction. (auth)

**32858** (AEC-tr-4509(p.287-9)) ON THE CHOICE OF OPTIMUM STATOR FREQUENCY WHEN MIXING LIQUID STEEL WITH THE AID OF A TRAVELLING ELECTROMAGNETIC FIELD. N. I. Bortnichuk and M. M. Krut'yanskii. Translated from *Voprosy Magnit. Gidrodinamiki i Dinamiki Plazmy*, Trudy Konf., Akad. Nauk Latv. S.S.R., Inst. Fiz., Riga, 1958, 337-9(1959).

A scale model is discussed, whose purpose is to determine the optimum stator frequency (between 0.15 and 0.8 cps) for a traveling-magnetic-field liquid steel mixing apparatus. The frequency is studied as a function of the metal's conductivity, the power output, etc. (T.F.H.)

**32859** (UCRL-Trans-686) INVESTIGATION OF THE PROPERTIES OF A PLASMA IN A MAGNETIC FIELD. A translation of *Issledovanie Svoistv Plazmy v Magnitnom Pole*. I. M. Zolototrubov, N. M. Ryzhov, I. P. Skoblik, and V. T. Tolok (Akademiya Nauk Ukr. S.S.R. Fiziko-Tekhnicheskii Institut). 1960. 9p.

A study was made of a highly-ionized plasma created by an electrodeless discharge in a tube which was placed in the field of two single-turn coils. The variable magnetic field which was obtained by discharging a capacitance battery on these coils created a radial compression of the plasma and secured its retention at the expense of trap geometry. A diagram is included of the experimental equipment and the distribution of the magnetic field along the axis. When the apparatus was slightly modified by increasing the inductance of the coils, the intensity of the magnetic field was almost doubled. The longitudinal oscillations of the plasma were searched for by means of high-speed photography done through a split parallel to the magnetic field. No longitudinal oscillations were detected, but the radial oscillations were clearly visible. (C.H.)

**32860** FLUCTUATION OF AN ELECTROMAGNETIC FIELD IN PLASMA. F. G. Bass. *Izvest. Vysshikh Ucheb. Zavedenii, Radiofiz.*, 4: 465-75(1961).

Electromagnetic wave fluctuations, which result from random variations of the magnetic field and electron concentration, in a magnetically active plasma are studied theoretically. The perturbation method is used for evaluating the fluctuations due to amplitude, phase, and angle of arrival. The results of the statistical characteristics of the electromagnetic field are applicable in the distal and proximal zones for both long and short paths of the electromagnetic wave. The limit case for the strong magnetic fields is also investigated. The damping factor of the mean field is obtained without recourse to energy considerations. For a slowly fluctuating wave function of three coordinates the mean square fluctuation of the phase equals the mean square of the relative fluctuation of amplitude and differs from the mean square phase in the distal zone by a factor of 0.5. (N.W.R.)

**32861** GENERAL SPHERICAL HARMONICS FORMULATION OF PLASMA BOLTZMANN EQUATION. Chester P. Carpenter (Avco Corp., Cincinnati) and Fritz W. Mezger. *J. Math. Phys.*, 2: 694-701(Sept.-Oct. 1961).

The Boltzmann equation for the phase space distribution



of electrons in the presence of ions is reduced to an infinite set of differential equations which do not involve angle variables. The usual method of expanding the electron phase space distribution function in terms of spherical harmonics is employed and it is assumed, in analyzing the scattering process, that the ion velocities can be neglected in comparison with the electron velocities. The expansion includes both polar and azimuthal angles obviating the assumption of symmetry about a polar axis made in previous work. The differential equation for the general component of the spherical harmonics expansion is derived and explicit equations for the first few components are presented. The component equations are seen to be considerably more tractable for cases which involve electric and/or magnetic fields along a single axis. (auth)

**32862 PLASMA OSCILLATIONS IN EXTERNAL FIELDS.** Masao Sumi (Electrical Communication Lab., Tokyo). J. Phys. Soc. Japan, 16: 1718-28 (Sept. 1961). (In English)

Plasma oscillations are considered under uniformly applied electric and magnetic fields. When the external field is so weak that the particle runaway is not yet appreciable and the drift motion between electrons and ions is regarded as quasi-stationary compared with the oscillation frequency and particle gyrations, the usual Laplace transform method can be approximately employed. The dispersion relation thus obtained describes the excitation of ion waves. Behaviors of these waves are discussed, their temporal developments being taken into account. (auth)

**32863 AXIAL CONDUCTION AND RADIATION LOSSES IN A STABILIZED LINEAR PINCH.** A. H. de Borde and F. A. Haas (English Electric Co. Ltd., Nelson Research Labs., Stafford, Eng.). Nuclear Fusion, 1: 160-6 (July 1961). (In English)

Conduction and radiation losses are studied in a linear pinched discharge under steady conditions. The model selected is one in which the ohmic heating in a thin skin of current is equated to the radiation and axial conduction losses, the discharge being considered at a uniform pressure, which is determined by the Bennett relation modified to include the effect of a possible completely trapped axial magnetic field. Formulas for temperature and other physical quantities are presented and limiting forms considered in a variety of circumstances. The effect of thermoelectric phenomena is considered. Conditions under which the treatments is likely to be applicable are discussed. (auth)

**32864 LONGITUDINAL OSCILLATIONS IN A NEUTRALIZED ELECTRON BEAM WITH A BOUNDARY.** M. Yoshikawa (Tokyo Univ.). Nuclear Fusion, 1: 167-71 (July 1961). (In English)

Longitudinal oscillation of a bounded neutralized electron beam in a strong axial magnetic field is discussed. The beam is assumed to be cylindrical and to be confined in a conducting cylinder, or to be planar and to be held between two conducting plates. A sufficient and, in some cases, approximately necessary condition for stability is obtained. To be stable, the beam current should be below a certain value which depends on the electron velocity, the ratio of electron to ion mass, and the geometrical dimensions of the beam and the conductor. The validity of the approximation is studied. (auth)

**32865 RADIATION FROM A MODULATED BEAM OF CHARGED PARTICLES PENETRATING A PLASMA IN A UNIFORM MAGNETIC FIELD.** E. Canobbio (Max-Planck-Institut für Physik und Astrophysik, Munich). Nuclear Fusion, 1: 172-80 (July 1961). (In English)

The radiation from a density-modulated beam of ions,

which penetrates a plasma perpendicular to a strong magnetic field  $B_0$ , is investigated in two simplified situations: that in which the beam is an infinite plane parallel to  $B_0$ ; and that in which the beam is an infinite cylindrical surface parallel to  $B_0$ , the radius of the cylinder being the gyroradius of the beam particles. The latter beam can be constructed by injecting into a plasma a linear beam, modulated at a frequency that is an integral multiple of the gyrofrequency of the beam particles, and incident in a direction that forms a very small angle with a plane perpendicular to  $B_0$ . In both situations some resonances of the Poynting vector are found. The resonance, which occurs when the modulation frequency is equal to the "ion-resonance" frequency, is specifically investigated, taking into account the finite electric conductivity of the plasma. It is shown that, under appropriate conditions, the beam-plasma interaction at this resonance becomes very strong. (auth)

**32866 THEORY OF ČERENKOV AND CYCLOTRON RADIATIONS IN PLASMAS.** Taro Kihara, Osamu Aono, and Ryo Sugihara (Tokyo Univ.). Nuclear Fusion, 1: 181-8 (July 1961). (In English)

Radiation from a charge  $q$  moving in a helix in a magnetoplasma is investigated theoretically. When the speed  $v$  is much larger than the thermal velocity,  $(m^{-1} kT)^{1/2}$ , of the plasma electrons, and the gyration frequency is much smaller than the plasma frequency  $\omega_0$ , the radiation power from the charge is  $(q^2 \omega_0^2 / 2v) \ln(v^2 / m^{-1} kT)$ . Cyclotron radiation from an electron with nonrelativistic speed decreases to zero as plasma density increases. For a  $\beta$  positron in a dilute plasma, however, the radiation is strengthened. This strengthened radiation from a positron decreases with increasing  $\omega_0^2 / \omega_H^2$  and becomes zero for  $\omega_0^2 / \omega_H^2 \geq 2$  ( $\omega_H$  = gyration frequency of the plasma electron). Damping of the Čerenkov radiation caused by collisions of plasma electrons is also discussed. (auth)

**32867 CYCLOTRON RADIATION BY IONS IN PLASMA.** V. I. Pistunovich and V. D. Shafranov (Inst. of Atomic Energy, Moscow). Nuclear Fusion, 1: 189-94 (July 1961). (In Russian)

The intensity of radiation emitted by fast ions in cold plasma is determined. This problem arises in connection with observations made on the OGRA device of resonance peaks of the electric field strength, e.g. at the ion cyclotron frequency and its overtones. Although these observations are made outside the wave zone, it is expected that the experimental dependence of the number of observed peaks on the density of cold plasma must also be reflected in the intensity of radiation. Calculations show that, with an increase of the ion velocity and of the plasma density, the maximum of the intensity of radiation actually shifts toward the high frequencies. This shift is analogous to the shift of the maximum of the radiation intensity for synchrotron radiation by an electron that has a velocity approaching the velocity of light. In the case of ions in plasma the role of the velocity of light is played by the phase velocity of the electromagnetic waves in the plasma. This velocity approaches the Alfvén velocity  $c_A = B_0 / \sqrt{4\pi m_i n_0}$  in the region which is important in the calculations. Therefore, the high overtones already become effective at a comparatively small ion velocity,  $0 \sim c_A \ll c$ . (auth)

**32868 MEASUREMENT OF THE PLASMA ELECTRON TEMPERATURE IN A STRONG SHOCK WAVE.** T. I. Filippova, N. V. Filippov, V. V. Zhurin, and V. P. Vinogradov (Inst. of Atomic Energy, Moscow). Nuclear Fusion, 1: 195-7 (July 1961). (In Russian)

The electron conductivity of deuterium plasma behind a

strong shock wave is measured by the method of displaced magnetic flux. At shock-wave velocities from  $0.9 \times 10^7$  to  $1.25 \times 10^7$  cm/sec, electron temperatures ( $T_e$ ) of 50 to 90 eV are found. A comparison between the observed  $T_e$  and the  $T_e$  computed from the shock-wave velocity is made. Piezoelectric measurements and compression of plasma by a strong magnetic field yield exactly the same value of the gas-kinetic pressure of plasma. (auth)

**32869** LOSS OF PARTICLES IN A PINCHED DISCHARGE IN AN AXIAL MAGNETIC FIELD. R. K. Jaggi (Univ. of Maryland, College Park). Nuclear Fusion, 1: 198-200 (July 1961). (In English)

A calculation of the loss of deuterons from a pinched current to the wall of the container is given, taking into account an axial magnetic field. It is found that such a field can materially reduce the particle loss. (auth)

**32870** THERMONUCLEAR REACTION RATES. J. L. Tuck (Los Alamos Scientific Lab., N. Mex.). Nuclear Fusion, 1: 201-2 (July 1961). (In English)

Reaction rate curves for the reaction  $D(d, np)D$ ,  $D(d, p)T$ , and  $D(d, n)He^3$  are presented as functions of the incident deuteron energy  $T$ , for  $T$  from 1 to 400 keV. A method is given for finding the individual  $n$  and  $p$  yields in the  $D(d, np)D$  reaction. (T.F.H.)

**32871** MAGNETOHYDRODYNAMIC METHOD OF INJECTING CHARGED PARTICLES INTO A MAGNETIC FIELD. C. C. Chang (Univ. of Minnesota, Minneapolis). Nuclear Instr. & Methods, 12: 345-8 (July 1961). (In English)

A new scheme of injecting high-energy charged particles into a plasma accelerator or thermonuclear device such as Astron is described. The injection can be carried out at small or even zero injection angle with a plane being perpendicular to the applied uniform magnetic field. The orbiting particles are estimated not to hit the injection systems which can be kept safely at reasonable radial clearance from the trajectory and orbit envelopes of the charged particles, for instance the location of the cylindrical E-layer. The method can be applied to inject charged particles without much restriction to its energy level. The attachments to the regular injection system such as electron gun are simple, economical and easy to develop. (auth)

**32872** EFFECT OF COLLISIONS ON THE LANDAU DAMPING OF PLASMA OSCILLATIONS. P. M. Platzman and S. J. Buchsbaum (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. Fluids, 4: 1288-92 (Oct. 1961).

The effect of collisions on the Landau damping of a one-dimensional longitudinal plasma oscillation in the absence of a magnetic field is analyzed. It is found that in a steady state, collisions (no matter how few in number) affect the velocity distribution of the trapped electrons and thus play a major role in determining the Landau damping. When the damping is small ( $\text{Im } k \ll \text{Re } k$ ), it is reduced from its collisionless value by a factor  $\nu_c^2 / (\nu_c^2 + \Omega^2)$  where  $\nu_c$  is the electron collision frequency for momentum transfer and  $\Omega^2 = eEk/m$  is the frequency of oscillation of a trapped electron in the approximately parabolic potential trough of the wave. (auth)

**32873** DIFFUSION AND RECOMBINATION OF A HIGHLY IONIZED COLD PLASMA IN A MAGNETIC FIELD. N. D'Angelo and N. Rynn (Princeton Univ., N. J.). Phys. Fluids, 4: 1303-6 (Oct. 1961). (MATT-74)

Measurements of the diffusion coefficients of cold, highly ionized cesium and potassium plasmas across a magnetic field are described. The field was varied between 3000 and 9000 gauss, the ion density between  $10^{10}$  and  $10^{12}$  cm $^{-3}$ . No

current was passed through the plasma. The results support the view that diffusion proceeds according to the predictions of the classical theory ( $D_{\perp} \sim 1/B^2$ ). No agreement is possible with Bohm's diffusion theory. Also, some support is given to the theory of recombination through electron-electron-ion collisions and radiative cascading between excited states. (auth)

**32874** PARTICLE SURFACES FOR HIGH-ENERGY ELECTRONS IN A STELLARATOR. E. B. Meservey and L. P. Goldberg (Princeton Univ., N. J.). Phys. Fluids, 4: 1307-14 (Oct. 1961). (MATT-68)

A simple theory of high-energy ("runaway") electron surfaces in a stellarator is presented. X-ray intensity measurements qualitatively confirm the prediction of the simple theory, that in a machine whose figure-eight twist is negative (i.e., each U bend rotated counterclockwise as seen from beyond that U bend), runaway surfaces drift toward the center of curvature (inside) of the stellarator loop for accelerating field  $E$  parallel to confining field  $B$  and toward the outside for  $E$  antiparallel to  $B$ . The time behavior of x-ray intensity indicates that the actual runaway surfaces do not have the predicted circular cross section but have, superposed on this, perturbations of  $m$ -fold azimuthal symmetry at values of plasma current corresponding to the predicted ranges for various modes of the "kink" instability. (auth)

**32875** OBSERVATIONS OF IONIC SOUND WAVES IN PLASMAS. I. Alexeff and R. V. Neidigh (Oak Ridge National Lab., Tenn.). Phys. Rev. Letters, 7: 223-5 (Sept. 15, 1961).

Standing ionic sound waves are observed in plasmas in cylindrical and spherical discharge tubes. H, He, Ne, Ar, Kr, and Xe are used. As many as 4 harmonics are observed for one gas. (T.F.H.)

**32876** MAGNETOHYDROSTATIC EQUILIBRIUM FOR FLUID ENCLOSED IN AN AXISYMMETRIC TOROIDAL SURFACE. Yusuke Kato (Kobe Univ., Japan). Progr. Theoret. Phys. (Kyoto), 26: 123-30 (July 1961). (In English)

The solution of the magnetohydrostatic equations for an ideally conducting fluid contained in an axisymmetric toroidal surface is investigated. The basic equations are reduced to a partial differential equation of the second order, with two variables, and of elliptic type. This equation contains two arbitrary functions which give nonlinear terms. The Dirichlet problem for this equation has a solution that gives the equilibrium conditions. The vacuum field sustaining the equilibrium is examined for a toroidal fluid with circular cross section. (auth)

**32877** CONTROLLED THERMONUCLEAR FUSION RESEARCH. "Review Series—Monograph Collection No. 17" of the International Atomic Energy Agency, Vienna. K. Bockasten, R. Hallin, S. I. Herlitz, L. Hogberg, N. R. Nilsson, S. Svennerstedt, and K. Vogel. 1961. 55p. (STI/PUB/15/17). \$1.00 (IAEA).

The status of controlled thermonuclear fusion research is reviewed, with particular attention to the development since the 1958 Geneva Conference. A survey of the basic requirements on a fusion reactor is given, followed by a brief discussion of theoretical results on transport processes in plasmas, stability, and wave motion. The most commonly used diagnostic methods are listed, with more detailed comments on optical spectroscopy and microwave methods. The various methods for production, heating, and confinement of plasmas (pinches, mirror machines, stellarators, shock heating, etc.) are described, and experimental results are reviewed. There are about 200 references and a list of bibliographies on plasma physics. (auth)



**32878 IMPROVEMENTS IN OR RELATING TO A PROCESS FOR ENERGY PRODUCTION BY NUCLEAR FUSION.** Erwin Willy Becker. British Patent 879,218. Oct. 4, 1961.

A method of producing energy by nuclear fusion is outlined which attains high efficiency by using the fuel (hydrogen or helium) in the form of a liquid jet instead of a gas jet. The outer gaseous zone of the liquid jet emitted by a nozzle is stripped off by screens. An apparatus for putting the method into effect is described. (D.L.C.)

## Theoretical Physics

**32879 (AFOSR-1137) STOCHASTIC MODELS FOR MANY-BODY SYSTEMS. I. INFINITE SYSTEMS IN THERMAL EQUILIBRIUM.** Robert H. Kraichnan (New York Univ., New York. Inst. of Mathematical Sciences). July 1961. Contract AF49(638)-341. 74p. (HT-9)

Some model Hamiltonians are proposed for quantum-mechanical many-body systems with pair forces. In the case of an infinite system in thermal equilibrium, they lead to temperature-domain propagator expansions which are expressible by closed, formally exact equations. The expansions are identical with infinite subclasses of terms from the propagator expansion for the true many-body problem. The two principal models introduced correspond, respectively, to ring and ladder summations from the true propagator expansion, but augmented by infinite classes of self-energy corrections. The latter are expected to yield damping of single-particle excitations. The eigenvalues of the ring and ladder model Hamiltonians are real, and they are bounded from below if the pair potential obeys certain conditions. The models are formulated for fermions, bosons, and distinguishable particles. In addition to the ring and ladder models, two simpler types are discussed, one of which yields the Hartree-Fock approximation to the true problem. A novel feature of all the model Hamiltonians, except the Hartree-Fock, is that they contain an infinite number of parameters whose phases are fixed by random choices. Explicit closed expressions are obtained for the Helmholtz free energy of all the models in the classical limit. (auth)

**32880 ON THE ÚLEHLA-PETRAŠ WAVE EQUATION.** J. Formánek (Faculty of Technical and Nuclear Physics, Prague). Czechoslov. J. Phys., 11B: 545-53(1961). (In English)

The Petráš and the Úlehla wave equations of an anomalous electrically charged particle with spin one half are examined and their mutual relation as well as connection with the usual Dirac-Pauli equation are clarified. (auth)

**32881 A PROBLEM OF ANALYTIC COMPLETION RELATED TO THE JOST-LEHMANN-DYSON FORMULA.** J. Bros, A. Messiah, and R. Stora (Centre d'Etudes Nucleaires, Saclay, France). J. Math. Phys., 2: 639-51 (Sept.-Oct. 1961).

Functions of a complex four-vector  $Q$  are considered which are analytic in the domain formed by the future tube:  $\text{Im}Q$  in the future light-cone, the past tube:  $\text{Im}Q$  in the past light-cone, and a complex neighborhood of a domain  $R$  of real  $Q$  space limited by two space-like surfaces. It is shown, by using techniques pertaining to the theory of analytic functions of several complex variables, that all such functions can be analytically continued in a larger domain which coincides with the one predicted by the Jost-Lehmann-Dyson formula. (auth)

**32882 ROLE OF THE ASYMPTOTIC CONDITION IN A LAGRANGIAN FIELD THEORY.** M. Wellner and R. B.

Curtis (Indiana Univ., Bloomington). J. Math. Phys., 2: 651-5 (Sept.-Oct. 1961).

The scattering operator of Feynman and Dyson for a self-interacting neutral scalar field is derived from a Lagrangian without the use of a canonical transformation between the Heisenberg and interaction pictures. (auth)

**32883 ACNODES AND CUSPS ON LANDAU CURVES.** R. J. Eden, P. V. Landshoff, J. C. Polkinghorne, and J. C. Taylor (Cambridge Univ., Eng.). J. Math. Phys., 2: 656-63 (Sept.-Oct. 1961).

It is shown that the Landau curve for a reduced sixth-order diagram can acquire acnodes and real cusps as the masses are varied. They are associated with complex singularities that under certain conditions are in the physical sheet and cause a breakdown of the Mandelstam representation. The problem of obtaining general criteria for acnodes and cusps is discussed. (auth)

**32884 WAVE EQUATIONS FOR SCALAR AND VECTOR PARTICLES IN GRAVITATIONAL FIELDS.** Stig Hjalmar (Royal Inst. of Tech., Stockholm). J. Math. Phys., 2: 663-6 (Sept.-Oct. 1961).

An earlier representation of the Kemmer wave equation in Riemann space is modified so as to remove the matrices, which in general have to be added to the differential operators of the equation. It is pointed out that the possibility of this removal is equivalent to the fact, known from Maxwell's equations, that if only scalars, vectors, and antisymmetrical tensors are involved, the field equations can be written with ordinary derivatives without explicit use of the affine connection. The wave equation is written in component form, and the photon zero mass case is obtained by means of the most general matrix mass term, without any questionable limiting process. (auth)

**32885 NEW APPROACH TO EINSTEIN'S EMPTY SPACE FIELD EQUATIONS.** E. T. Newman and L. A. Tamburino (Univ. of Pittsburgh). J. Math. Phys., 2: 667-74 (Sept.-Oct. 1961).

Tetrad formalism is used to derive a set of 36 scalar field equations which correspond to the ordinary field equations  $R_{\mu\nu} = 0$ . The scalar equations are obtained by beginning with a given Petrov type of empty-space Riemann tensor and applying the Ricci identity to each of the tetrad vectors. The unknowns or field variables become the 24 Ricci rotation coefficients, the number of which can always be reduced by the Bianchi identities and occasionally by tetrad transformations which leave the form of the Riemann tensor invariant. The use of these scalar field equations is illustrated by their application to a degenerate case of Petrov type I. It is believed that by this method all possible solutions of this particular case were found. (auth)

**32886 NEW APPROACH TO THE EINSTEIN AND MAXWELL-EINSTEIN FIELD EQUATIONS.** Ezra T. Newman (Syracuse Univ., N. Y.). J. Math. Phys., 2: 674-6 (Sept.-Oct. 1961).

The components of a "vierbein" system are introduced as field variables in place of the metric tensor in a Riemannian space. The Riemann tensor, which is then written in terms of these new variables, is used to reformulate the Einstein and Einstein-Maxwell equations with or without a cosmological constant. These field equations have as solutions metrics with Riemann tensor of predetermined algebraic properties. (auth)

**32887 EXACT STATISTICAL MECHANICS OF A ONE-DIMENSIONAL SYSTEM WITH COULOMB FORCES.**

A. Lenard (Princeton Univ., N. J.). J. Math. Phys., 2: 682-93 (Sept.-Oct. 1961). (MATT-64)

A system consisting of an equal number of positively and

negatively charged "sheets" is considered in thermal equilibrium, with motion restricted to one dimension. The configurational part of the partition function can be represented as a sum of terms, each a simple algebraic expression. The summation is performed with the technique of generating functions. The asymptotic form in the limit of an infinite system is obtained from the pole of the generating function closest to the origin. This pole is the solution of a certain transcendental equation for which an explicit analytic representation in terms of an infinite continued fraction is available. It is shown that this equation is identical with the characteristic equation associated with the even Mathieu functions of even order. In the limit, when the ratio of interparticle force to pressure is small, the system behaves as an ideal gas, the deviations from this state being expandable in powers of the square root of this ratio. In the opposite limit of large ratio, the particles associate in pairs of opposite charge, thus behaving like an ideal gas of neutral "molecules" which have an internal vibrational degree of freedom. The analysis may be generalized to include the effect of a constant external field. For a given pressure there is a critical field which can never be surpassed without disrupting equilibrium. (auth)

**32888 CONSTRUCTION OF SYMMETRY-ADAPTED FUNCTIONS IN THE MANY-PARTICLE PROBLEM.** R. K. Nesbet (Boston Univ.). *J. Math. Phys.*, 2: 701-9 (Sept.-Oct. 1961).

A new method is presented for obtaining many-particle angular momentum eigenfunctions and matrix elements of an invariant Hamiltonian. The same technique can be used to construct symmetry-adapted functions for any group of operators that commute with the Hamiltonian, and to simplify the evaluation of matrix elements in the symmetry-adapted basis. Applied to an arbitrary configuration, the method produces orthonormal functions identical with those that would be obtained by Schmidt orthogonalization of the projections of the original basis functions of the configuration. Because of this relationship, matrix elements of the Hamiltonian are greatly simplified, but the functions are obtained without explicitly constructing the projection operators or their matrix representations. To illustrate the method, it is applied to the spin coupling of configurations with three, four, and five particles outside closed shells, and to the two <sup>2</sup>D functions of the atomic configuration d<sup>3</sup>, in Russell-Saunders coupling. Tables of the coefficients needed to evaluate all independent matrix elements are obtained for these examples, and typical matrix elements are calculated. (auth)

**32889 SCHRÖDINGER SCATTERING AMPLITUDE.** [PART] I. Alex Grossmann and Tai Tsun Wu (Brandeis Univ., Waltham, Mass. and Harvard Univ., Cambridge, Mass.). *J. Math. Phys.*, 2: 710-13 (Sept.-Oct. 1961).

The Schrödinger scattering amplitude for a fixed potential is studied as a function of the three components of the initial momentum, the three components of the final momentum, and the square root of the energy. (auth)

**32890 SCHRÖDINGER SCATTERING AMPLITUDE.** [PART] II. Alex Grossman (Brandeis Univ., Waltham, Mass.). *J. Math. Phys.*, 2: 714-18 (Sept.-Oct. 1961).

Preceding results are used to indicate procedures of calculation of the scattering amplitude, obtain several expansions, find bounds on the variation of the amplitude under a change in the potential, and study multiple scattering. (auth)

**32891 THEORY OF MULTIPOLE RADIATION.** S. C. Snowdon (Midwestern Universities Research Assn., Madison, Wis.). *J. Math. Phys.*, 2: 719-22 (Sept.-Oct. 1961).

The decomposition of the electromagnetic field into longitudinal, transverse electric, and transverse magnetic field types is examined in relation to a similar decomposition of the sources. In general, three independent scalar aspects of the current and charge densities must be specified to provide longitudinal and transverse electromagnetic fields. If, in addition, it is required that the sources be continuous and spatially localized functions, only two independent scalar aspects of the sources are needed to provide the electromagnetic fields outside the sources. (auth)

**32892 EIGENVALUE PROBLEMS IN MATRIX MECHANICS.** Richard R. Chasman (Argonne National Lab., Ill.). *J. Math. Phys.*, 2: 733-5 (Sept.-Oct. 1961).

The techniques of the Heisenberg matrix mechanics are extended to treat all potentials of the form  $Q^{2n}$ , for  $n$  a positive integer. The square well ( $Q^\infty$ ) and the potential  $Q^4$  are treated in detail. (auth)

**32893 REMARKS ON THE CONTINUED FRACTION CALCULATION OF EIGENVALUES AND EIGENVECTORS.** Jerome D. Swalen (Harvard Univ., Cambridge, Mass. and Shell Development Co., Emeryville, Calif.), and Louis Pierce. *J. Math. Phys.*, 2: 736-9 (Sept.-Oct. 1961).

For eigenvalue problems in which the secular determinant has tridiagonal form, e.g., the rigid asymmetric rotor; the secular equation may be written in the form  $f(\lambda') = 0$ , where  $f(\lambda')$  is a continued fraction and  $\lambda'$  an eigenvalue. Furthermore, if the secular problem is of  $n$ th order, then the continued fraction  $f(\lambda')$  may be developed in  $n$  different ways. Since the eigenvalues are roots of a function  $f(\lambda)$ , it is convenient to find the eigenvalues by means of the Newton-Raphson iterative procedure. This requires that the derivative of  $f(\lambda)$  with respect to  $\lambda$  ( $f'(\lambda)$ ) be determined. An exact expression for  $f'(\lambda)$  is derived and it is shown that  $f'(\lambda')$  is in fact the norm of the eigenvector belonging to the eigenvalue  $\lambda'$ . A simple recursion formula, in continued fraction form, for the eigenvector elements is also derived. The Newton-Raphson procedure is further shown to be equivalent to the variational method for iterative calculation of eigenvalues. The former procedure has, however, the advantage of bypassing the necessity of solving a set of simultaneous equations. Advantage is taken of the relation between  $f'(\lambda')$  and the eigenvector of  $\lambda'$  to formulate a reasonable criterion for choosing the best possible development of  $f(\lambda)$  in order to avoid convergence to an undesired root of  $f(\lambda)$ . (auth)

**32894 CALCULATION OF THE EIGENVALUES OF A TRIDIAGONAL HERMITIAN MATRIX.** Louis Pierce (Univ. of Notre Dame, Indiana). *J. Math. Phys.*, 2: 740-1 (Sept.-Oct. 1961).

For real symmetric or Hermitian matrices with tridiagonal form, the secular equation may be written as a continued fraction equation  $f(\lambda) = 0$ .  $f(\lambda)$  is a member of a recursively defined sequence  $R^{(n)}(\lambda)$  of  $n$  continued fractions if the secular equation is of the  $n$ th order. The basis for a new method of computing the eigenvalues of such tridiagonal matrices is given. The method requires the determination of an integer-valued function  $P_n(\gamma)$  for a succession of values of  $\gamma$ , where  $P_n(\gamma)$  is a function only of  $n$  and the signs of the  $n$  terms in  $R^{(n)}(\gamma)$ . (auth)

**32895 REDUCED MATRIX ELEMENTS IN NUCLEAR SHELL THEORY.** V. K. Kembhavi (Karnatak Univ., Dharwar, India). *Nuclear Phys.*, 27: 38-40 (1961). (In English)

Using harmonic oscillator wave functions, reduced matrix elements were expressed in terms of Talmi integrals and  $3F_2$  series. The B coefficients of Brody, Jacob, and Moshinsky are shown to be related to  $3F_2$  series, and some recurrence relations for the B coefficients are obtained. A table of useful B coefficients is presented. (auth)



**32896** AN INTERPRETATION OF THE ISOBARIC SPIN SPACE. Th. A. J. Maris (Universidade do Rio Grande do Sul, Porto Alegre, Brazil). *Nuclear Phys.*, 27: 46-51(1961). (In English)

It is shown that the group of isobaric spin rotations is homomorphous with a certain group of Lorentz-invariant transformations of a 4-component spinor field. A simple interpretation of the isobaric spin operators of interacting fields as being quantities known from the Dirac theory seems possible. (auth)

**32897** RENORMALIZATION OF TIME-ORDERED GREEN'S FUNCTIONS. K. Nishijima (Univ. of Illinois, Urbana). *Phys. Rev.*, 124: 255-63(Oct. 1, 1961).

The renormalization of time-ordered Green's functions is carried out without reference to Feynman diagrams. The arguments are entirely based on the generalized unitarity condition and the parametric dispersion relations. The renormalization of the meson-nucleon interaction is studied, and then a close examination is given of the renormalization of quantum electrodynamics in a special gauge. Finally the connection between the subtraction constants in dispersion relations and renormalization constants is clarified in a simple model. (auth)

**32898** POTENTIAL SCATTERING AS OPPOSED TO SCATTERING ASSOCIATED WITH INDEPENDENT PARTICLES IN THE S-MATRIX THEORY OF STRONG INTERACTIONS. Geoffrey F. Chew and Steven C. Frautschi (Univ. of California, Berkeley). *Phys. Rev.*, 124: 264-8(Oct. 1, 1961).

A definition of a relativistic generalized potential is given, suitable at arbitrary energies for a pair of particles whose elastic scattering amplitude satisfies the Mandelstam representation. It is shown that the generalized potential plays a role in the dynamics analogous to that of the ordinary nonrelativistic potential in a Schrödinger equation and determines the scattering to the same extent. Below the threshold for inelastic processes the generalized potential is real and its energy dependence in the elastic region is expected for certain particle combinations (such as the nucleon-nucleon) to be weak. In such cases one may uniquely define, for use in the Schrödinger equation, an energy-independent ordinary potential that coincides with the potential of Charap and Fubini. In general, when the potential is complex and energy-dependent the dynamical problem involves iteration of an integral equation deduced by Mandelstam. The generalized potential may be decomposed according to range and it is shown that keeping only the long- and medium-range parts, corresponding to transfer of one or two particles, is almost equivalent to the "strip approximation." Finally, a general definition is given of "pure potential scattering" as opposed to scattering associated with "independent" particles, either stable or unstable, and a variety of experimental situations are discussed with respect to this distinction, which is shown to be susceptible to experimental test. (auth)

**32899** TWO PICTURES OF THE STRONG-COUPLING METHOD. Helmut Jahn (Inst. for Advanced Study, Princeton, N. J.). *Phys. Rev.*, 124: 280-6(Oct. 1, 1961).

In the strong-coupling method of the meson theory two different pictures have been used. One picture exhibits the isobaric nature of the meson-nucleon interaction by expressing the Hamiltonian in terms of the integrals of motion of the total system. It may be called the rotation picture. In the other picture the isobaric dependency comes out by splitting the total system into a free field system and a compound nucleon system, such that the interaction between them vanishes for infinite  $g$ . It may be called the

splitting picture. These two pictures are compared with each other. The difference between them with regard to the scheme of the strong-coupling approximation method, especially with regard to the calculations of isobaric energy corrections and resonance scattering, is investigated. (auth)

**32900** OBSERVABLES IN THE EXTREME RELATIVISTIC REPRESENTATION OF THE DIRAC EQUATION. P. M. Matthews and A. Sankaranarayanan (Univ. of Madras). *Progr. Theoret. Phys. (Kyoto)*, 26: 1-6(July 1961). (In English)

A choice of operators is given to represent dynamical variables of a Dirac particle, in the extreme relativistic representation. (auth)

**32901** ON THE QUANTIZATION OF PHYSICAL SPACE-TIME OPERATORS. [PART] II. Ichie Watanabe (Tokyo Univ.). *Progr. Theoret. Phys. (Kyoto)*, 26: 7-21(July 1961). (In English)

The characteristic features of an altered field theory are analyzed by using the interaction representation. It is shown that the altered theory gives the same result for the transition matrix as does the conventional field theory. (auth)

**32902** SELF-TRAPPING OF AN ELECTRON BY THE ACOUSTICAL MODE OF LATTICE VIBRATION. [PART] I. Yutaka Toyozawa (Tokyo Univ.). *Progr. Theoret. Phys. (Kyoto)*, 26: 29-44(July 1961). (In English)

The importance of the acoustical mode of lattice vibration for self-trapping of an electron is shown. It is shown that when the coupling constant between the electron and the acoustical mode vibration exceeds a certain critical value, the effective mass of the electron changes discontinuously to such an enormous value that the electron is practically allowed to take a localized self-trapping state as an eigenstate. This model is in contrast with the case of the polaron, in which the effective mass changes continuously with coupling constant. This difference is attributed to the different force range of electron-lattice interaction in the two cases. (auth)

**32903** THE PAIR CORRELATION FUNCTION OF AN IMPERFECT ELECTRON GAS IN HIGH DENSITIES. Seizo Ueda (Tokyo Univ.). *Progr. Theoret. Phys. (Kyoto)*, 26: 45-50(July 1961). (In English)

The pair correlation function ( $g$ ) or the relative pair distribution function, of a high density imperfect electron gas in the ground state is computed numerically versus the distance between two electrons. The cases are considered in which the electrons have either antiparallel or parallel spins, for three values of density for each case. In the latter case  $g$  is computed, using an approximate expression, only over distances small compared with the reciprocal of the Fermi momentum divided by  $\hbar$ . In both cases  $g$  increases monotonously with distance for a given density and decreases with density for a fixed distance, because of the increasing effect of Coulomb repulsion with decreasing density. (auth)

**32904** PARTICLE-HOLE BOUND STATES IN THE MANY FERMION SYSTEM. Tetsuo Gotô (Nihon Univ., Tokyo). *Progr. Theoret. Phys. (Kyoto)*, 26: 84-98(July 1961). (In English)

Bound states of a particle-hole pair are investigated by means of the Bethe-Salpeter equation. Besides the density oscillation, it is shown that transverse collective oscillations are possible. The conditions for the existence of a transverse wave are studied. (auth)

**32905** SOME CONVERGING EXAMPLES OF THE PERTURBATION SERIES IN THE QUANTUM FIELD

**THEORY.** Yusuke Kato (Kobe Univ., Japan). *Progr. Theoret. Phys.* (Kyoto), 26: 99-122 (July 1961). (In English)

Properties of the Hamiltonian operator of the quantized field are studied, in the framework of the theory of Hilbert space. The fixed-source theory and the boson-fermion interaction are investigated, in the cases of discrete and continuous spectra. The total Hamiltonian operator ( $\mathcal{H}$ ) is defined first in a domain that dense in the Hilbert space, under the condition that the interaction form factor in the momentum space is "square integrable". Then it is shown that  $\mathcal{H}$  as a self-adjoint operator can be determined in terms of the perturbation series for every finite value of the coupling constant, if the boson mass is not zero; and that  $\mathcal{H}$  is the unique self-adjoint extension of the symmetric operator defined initially. For the boson-fermion interaction with continuous spectrum, some additional condition on the interaction form factor is needed. The perturbation series of the S-matrix element for scattering is discussed in the framework of the wave packet formulation. (auth)

**32906** ON A CONVERGENT MODEL OF QUANTUM FIELD THEORY WITH INDEFINITE METRIC. Kan-ichi Yokoyama (Tokyo Inst. of Tech.). *Progr. Theoret. Phys.* (Kyoto), 26: 131-47 (July 1961). (In English)

A convergent quantum field theory model with indefinite metric is proposed, for the case of an indirect interaction between a physical neutral scalar field and a physical spinor field, by introducing four kinds of unphysical spinor fields that play the roles of the intermediate states connecting the two physical fields. Two of the unphysical fields are set to have negative anticommutators, and this fact makes the metric of the Hilbert space indefinite; nevertheless it is shown that the unitarity of the actual S-matrix holds strictly. The result is that every vertex in the usual local theory is exactly replaced with some kind of extended vertex in this model, which guarantees a sufficient convergency for all results. Although the extended vertex in this model becomes singular at the two momentum values depending on the masses of unphysical fields and the cou-

pling constant, it is shown that there remains a considerable degree of freedom for controlling the stable mass levels of the physical particles. (auth)

**32907** OPERATOR EQUATIONS IN TWO FIELD THEORY MODELS. P. G. Federbush (Massachusetts Inst. of Tech., Cambridge). *Progr. Theoret. Phys.* (Kyoto), 26: 148-50 (July 1961). (In English)

Two soluble relativistic field theory models are considered. Both models are two-dimensional, and both models have infinite renormalization constants. It is shown that the current operators for these models satisfy local field equations. (T.F.H.)

**32908** A NEW MODEL FOR THE HIGH ENERGY NUCLEAR INTERACTION. Shun-ichi Hasegawa (Tokyo Univ.). *Progr. Theoret. Phys.* (Kyoto), 26: 150-2 (July 1961). (In English)

The number of secondary particles emitted in shower jets is plotted as a function of  $\log(\tan \theta)$ , and it is shown that the particles are emitted in bunches. These bunches, or "quanta", are interpreted as follows: in a high-energy collision, several polarized "quanta" are emitted; each "quantum" is identified as a composite baryon-antibaryon pair, which later decays into  $\pi$  mesons, K mesons, etc. (T.F.H.)

**32909** HARD CORE AND SHAPE PARAMETER IN THE EFFECTIVE RANGE EXPANSION. T. Hamada and I. D. Johnston (Univ. of Sydney). *Progr. Theoret. Phys.* (Kyoto), 26: 153-4 (July 1961). (In English)

The shape parameter (P) in the effective range expansion for the  $^1S_0$  nuclear scattering phase shift is considered. Purely phenomenological nuclear potentials require that P be negative for cases in which the potential has a hard core radius  $> 0.3$  fermi; this requirement is in probable disagreement with the experimental data. A potential is shown, however, with a hard core radius of 0.4769 fermi, for which P is small but definitely positive. This singlet even parity potential is of the form (one-pion-exchange potential + short-range singular phenomenological potential). (T.F.H.)



# REACTOR TECHNOLOGY

## General and Miscellaneous

*Refer also to abstract 32284*

**32910** (ANL-6289) CASTING OF EBR-II-TYPE TRANSIENT TEST ELEMENTS AND EQUIPMENT DEVELOPMENT. H. F. Jelinek and P. L. Dewez (Argonne National Lab., Ill.). Sept. 1961. Contract W-31-109-eng-38. 33p.

Three groups of alloy fuel pins of different enrichment were made for the TREAT reactor with the aid of the EBR-II injection-casting equipment. The fuel pins were inspected for diametral variation, surface condition, length, internal porosity, and weight. The casting of these various small batches from time to time and the need for additional information on injection casting technology determined the design and construction of an experimental Vycor injection-casting furnace. The experimental furnace, in addition to the use of Vycor molds, was provided with a Vycor shell to permit visual observation of the casting technique. A series of five experimental melts were made to evaluate the performance of the machine. The results proved the furnace capable of producing good castings in small batch sizes. (auth)

**32911** (ANL-6334) STUDIES OF FAST REACTOR FUEL ELEMENT BEHAVIOR UNDER TRANSIENT HEATING TO FAILURE. I. INITIAL EXPERIMENTS ON METALLIC SAMPLES IN THE ABSENCE OF COOLANT. C. E. Dickerman, E. S. Sowa, D. Okrent, J. Monaweck, and L. B. Miller (Argonne National Lab., Ill.). Aug. 1961. Contract W-31-109-Eng-38. 96p.

Meltdown tests on single metallic unirradiated fuel elements in TREAT are described. The fuel elements (EBR-II Mark I fuel pins, EBR-II fuel pins with refractory Nb or Ta cladding, and Fermi-I fuel pins) are tested in an inert atmosphere, with no coolant. The fuel elements are exposed to reactor power bursts of 200 msec to 25 sec duration, under conditions simulating fast reactor operations. For these tests, the type of power burst, the integrated power, the fuel enrichment, the maximum cladding temperature, and the effects of the test on the fuel element are recorded. (T.F.H.)

**32912** (ANL-6406) CALCULATIONS FOR ZPR-VII FLUX-TRAP REACTORS WITH HEAVY WATER-MODERATED CORES. E. M. Pennington (Argonne National Lab., Ill.). Aug. 1961. Contract W-31-109-eng-38. 31p.

Calculations were made relating to flux-trap reactors constructed in the ZPR-VII critical assembly having heavy water-moderated cores of THUD or Babcock and Wilcox (BW) fuel. The flux-trap regions consisted of heavy water except for a few light water flux traps with THUD-fueled cores. Various flux ratios and quantities, such as ratios of maximum thermal flux to maximum power density or total core power, are compared for THUD-fueled lattices. In connection with the BW-fueled lattices, which have thin cores with high resonance absorption, a study is made of reactors having cores with  $k_{\infty} < 1$ . It is shown that it is possible for a reflected reactor having a core with  $k_{\infty} < 1$  to be critical if  $k_{\infty}/p > 1$ , where  $p$  is the resonance escape probability, and if the dimensions and material constants involved are of suitable magnitudes. (auth)

**32913** (ANL-6409) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, AUGUST 1961. (Argonne

National Lab., Ill.). Sept. 15, 1961. Contract W-31-109-eng-38. 72p.

Progress is reviewed on the following reactors: EBWR; Borax-V; ZPR-III; ZPR-VI; ZPR-IX; EBR-I; and EBR-II. An outline of fast and slow reactor safety studies in TREAT is presented. Progress is also reported in applied nuclear and reactor physics; development of reactor fuels, materials, and components; heat engineering technology; separation processes; and advanced reactor concepts. (T.F.H.)

**32914** (ANL-6433) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, SEPTEMBER 1961. (Argonne National Lab., Ill.). Oct. 15, 1961. Contract W-31-109-eng-38. 65p.

Data from examination of blade-type control rods which were used in BORAX are discussed. Operation and maintenance of EBWR is outlined. In work on Borax V, modifications for easier installation of reactor and components is outlined followed by discussion of superheat fuel element development, and fabrication of various reactor components. Borax reactor design is also reported along with information on development and testing. In research on sodium-cooled reactors, activities are summarized in the ZPR III and ZPR IV programs along with developmental work on EBR I and II. Studies on reactor safety are reported and activities in a program of nuclear technology and general support are outlined. (J.R.D.)

**32915** (APEX-629) MONTE CARLO RESEARCH SERIES: SLOWING-DOWN PROBABILITY IN A LATTICE GENERATED BY A THREE-REGION CELL OF FINITE LENGTH. J. R. Beeler and J. L. McGurn (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Jan. 1959. Contracts AF33(600)-38062 and AT(11-1)-171. 55p.

The slowing-down probability, cumulative absorption fraction, and end-leakage spectrum can be computed by program 0329 for a reactor lattice. The lattice is generated by a three-region hexagonal translation cell. An analysis of these quantities in terms of scattering-order components can be computed by program 0366. A maximum of 30 different chemical elements may be used in a calculation and/or material region. The running time for 1000 histories in a hydrogenous moderator is about 20 minutes. (auth)

**32916** (APEX-630) MONTE CARLO RESEARCH SERIES: PRE-SAMPLED ENERGY DEPOSITION METHOD FOR GAMMA HEATING CALCULATIONS. J. R. Beeler, M. D. McDonald, and J. F. Quinlan (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Aug. 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 13p.

A method for Monte Carlo gamma heating computation is described. This method uses pre-sampled energy deposition data rather than energy deposition values which are generated during computation. The method is restricted to systems with a maximum of twenty space regions. (auth)

**32917** (APEX-631) MONTE CARLO RESEARCH SERIES: DIRECTIONAL DIFFUSION COEFFICIENTS FOR A LATTICE GENERATED BY A THREE-REGION HEXAGONAL CELL. J. R. Beeler and J. D. Popp (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Oct. 1, 1958. Contracts AF33(600)-38062 and AT(11-1)-171. 14p.

A computer program was developed for calculating the directional diffusion coefficients for the three principal directions in a three-region lattice, generated by a hexag-

onal cell. It was written for the IBM-704 computer. These coefficients pertain to diffusion from a point source located either at the center of the cell or at the mid-point of a side of the generating cell boundary. (auth)

**32918** (APEX-641) THERMAL INSULATION DESIGNS FOR GAS-COOLED REACTORS. T. D. McLay (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Aug. 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 80p.

The problem of protecting structural material from high-velocity high-temperature gas streams (up to 2000°F) is a basic design problem found in gas-cooled nuclear power plants. A technology was accumulated to solve these design problems using fibrous thermal insulation as a basic design tool. The problems associated with providing protection of this material in reactors and hot ducting are discussed. Operating experiences are detailed to show the problems encountered in retaining insulation on the inside of a high-velocity gas stream. These methods of protecting structural components differ from normal design practice of allowing the structural components to operate at near gas-stream temperatures. Using internally insulated structures, reliable designs of reactors and associated ducting can be achieved without investing exotic materials that prove hard to fabricate. Lighter weight structures can be used. Experience gained in the solution of insulating structural components within the reactor indicated that reliable designs for 1000-hour operation are feasible. These designs, using a water heat sink, will protect structural aluminum from 1700°F gas streams with an investment of 0.100 in. of insulation. The designs for containing the hot gases between the reactor exit and the point where the gases flow through the turbine were successfully operated for 1000 hours at 1400° to 1600°F at Mach 0.3. Experiments were completed which indicated that feasible designs are available for operation up to 2000°F gas-stream temperature and Mach 0.3. (auth)

**32919** (APEX-705) REACTIVITY EFFECTS OF STRUCTURAL MATERIALS IN THE BEM-II B. K. V. Cooper and W. B. Henderson (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Aug. 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 27p.

Reactivity effects of 93.2% enriched alloy, molybdenum, iron, niobium, 310 stainless steel, 304 stainless steel, Inconel X, FeCrAl, zirconium, nickel, nichrome V, and chromium clad with FeCrAl, in the form of foils in the center cell of the BEM-II B minimum void, beryllium moderated critical experiment are reported. Nineteen-energy-level diffusion calculations with cell corrections from both coarse and fine energy detail were correlated with the measurements. The fine energy detail improved the correlation, mainly because resonance self-shielding and flux depression are more adequately treated, and residual discrepancies for the most part can be attributed to inadequacies in the cross section data. (auth)

**32920** (APEX-723A) GENERAL REACTOR SIZING TECHNIQUES. VOLUME I. AEROTHERMODYNAMIC OPTIMIZATION. W. Z. Prickett (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). June 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 45p.

A method is presented for the aerothermodynamic optimization of the net power and/or propulsive thrust per unit reactor free flow area of a nuclear power plant operating on the Brayton cycle. A system so optimized will translate into the minimum size, therefore the minimum weight, nuclear system for any selection of reactor materials, lifetime, and fuel loading. The theory and development of the

thermodynamic optimization process, the importance and effect of various parameters, and specific methods to be employed in the optimization of the various forms of the Brayton cycle are discussed. A sample calculation for the case of the ramjet application is included. The results of the application of these techniques to any Brayton cycle system may be used in conjunction with nuclear sizing methods, for beryllia-moderated reactors, to determine the required reactor size as a function of fuel loading and reactivity requirements. (auth)

**32921** (BMI-1524(Del.)) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING JUNE 1961. Russell W. Dayton and Clyde R. Tipton, Jr. (Battelle Memorial Inst. Columbus, Ohio). July 1, 1961. Contract W-7405-Eng-92. 104p.

Progress is reported on reactor materials and components; studies of fuels; general fuel element development; gas-pressure bonding of ceramic, cermet, and dispersion fuel elements; development of uranium carbide; growth of UO<sub>2</sub> single crystals; radioisotope and radiation applications; materials development and evaluation; coated-particle fuel materials; problems associated with the recovery of spent reactor fuel elements; development of fabrication processes for cold bonding of Zircaloy-2 to type 410 stainless steel; radiation effects study of candidate fuel materials for MGCR; radiation studies of SM-2 fuels; gas-cooled reactor program; corrosion of Th and U under storage conditions; and gas-pressure bonding of beryllium-clad elements. (M.C.G.)

**32922** (GA-1850) GAM-1: A CONSISTENT P<sub>1</sub> MULTI-GROUP CODE FOR THE CALCULATION OF FAST NEUTRON SPECTRA AND MULTIGROUP CONSTANTS. G. D. Joanou and J. S. Dudek (General Atomic Div., General Dynamics Corp., San Diego, Calif.). June 28, 1961. Contract AT(04-3)-314. 140p.

GAM-I is an IBM-7090 machine code developed for the calculation of few or multigroup constants in reactor theory. A description is given of the mathematical model used to characterize the physical situation. The P<sub>1</sub> equations were integrated over quarter-lethargy units from 10 Mev to 0.414 ev, yielding a total of 68 groups. The advantages gained by GAM-I over existing procedures are outlined. (B.O.G.)

**32923** (HW-67255) EVALUATION OF CHLORINE INHIBITION OF GRAPHITE OXIDATION AS A GAS-COOLED REACTOR SAFEGUARD. R. E. Dahl (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 1961. Contract AT(45-1)-1350. 50p.

Chlorine is concluded to be a potential safeguard for prevention and control of runaway oxidation in gas-cooled graphite-moderated reactors because of its effectiveness, low cost, and the relative simplicity involved in storage and application. Chlorine was tested as an oxidation inhibitor in the presence and absence of ionizing radiation and found to be effective. Chlorine reduced oxidation rates by a factor of five when present in chlorine-to-oxygen mole ratios of 0.1. The mechanism postulated was chlorine chemisorption on active carbon sites on the graphite surface, essentially poisoning the surface. A rate law derived on this premise agreed with observed data. Chlorine was also studied under combustion conditions to test its effect on ignition temperature and in extinguishing combustion. One percent chlorine extinguished graphite combustion at 1400°C. (auth)

**32924** (IDO-16705) ORGANIC COOLANT REACTOR PROGRAM. Quarterly Report, January 1-March 31, 1961.



(Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). July 21, 1961. Contract AT(10-1)-205. 84p.

Pyrolytic and radiolytic tests on organic coolants are described. The chemical analysis of a high-boiling polyphenyl that is formed upon irradiation of terphenyl is outlined. The reclamation of high boilers by hydrocracking over catalysts is examined. Various stabilizers are tested with regard to their inhibition of radiolysis. Thermal stability tests are performed on several industrial oils; the effects of dewaxing and/or hydrodealkylating of these oils on their stability are studied. Progress on the design of fuel and coolant technology loops for the EOCR is reported. Reactor physics calculations are carried out for the EOCR for several proposed core loadings. Design progress on the EOCR is discussed. (T.F.H.)

**32925** (IDO-16716) QUARTERLY TECHNICAL REPORT [ON] SPERT PROJECT, APRIL, MAY, JUNE 1961. F. Schroeder, ed. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Sept. 15, 1961. Contract AT(10-1)-205. 34p.

The kinetic behavior of 4% enriched  $\text{UO}_2$  fuel pins is investigated in SPERT I, using step and ramp reactivity insertion functions. The step-wise insertions are used to study self-limiting power excursions. The static parameters of this core are also measured. Self-limiting power excursions are studied in a  $\text{D}_2\text{O}$ -moderated core in SPERT II, using step-wise reactivity insertions. The kinetic behavior of SPERT III is studied by power excursion tests. The SPERT III excursions studied have initial reactor periods of 20, 40, and 150 msec. (T.F.H.)

**32926** (JPL-TR-32-133) OPTIMIZATION OF CONDENSING TEMPERATURE FOR NUCLEAR TURBOELECTRIC SPACE POWER PLANT. J. P. David (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Aug. 1, 1961. Contract NASw-6. 13p.

In order to scope out operating parameters for a nuclear electric power plant, a scheme was derived for selecting the ratio of radiator condensing temperature to turbine inlet temperature. The optimum condensing temperature satisfies a set of approximate relations which minimize overall powerplant specific weight for any given electrical power output with respect to the fraction of plant weight which is radiator. As with all such analytical attempts, the validity of the results is contingent on the accuracy of the simplifying assumptions necessary to mathematically formulate the problem. These assumptions are presented and discussed. The analysis indicated that over the range of anticipated radiator weight fractions and deviations from Carnot cycle efficiency, a choice of condensing to saturated turbine inlet temperature ratio of 0.60 to 0.70 is warranted. The analysis did not consider any weight penalties associated with higher vapor specific volumes, or condensate pumping problems at lower condensing temperatures. (auth)

**32927** (NAA-SR-4515) METALLURGICAL ASPECTS OF SRE FUEL ELEMENT DAMAGE EPISODE. J. L. Ballif (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 15, 1961. Contract AT-11-1-GEN-8. 46p.

An investigation of the metallurgical aspects of the SRE fuel element episode, that occurred July 26, 1959, has been completed. A total of ten hot cell examinations and two special tests were made, with both damaged and undamaged fuel elements from the reactor, to determine causative factors. The results show that iron-uranium alloy melting was present. The fuel element channel examined contained ample carbonaceous and/or oxide residue to block the coolant flow, either intermittently or on a permanent basis.

Evidence of rapid thermal cycling of the fuel element through the alpha-beta transformation temperature is presented and is suggested as a second mode of fuel element damage. Investigation of the cladding and structural materials indicated that no damage had occurred from either carburization or from nitriding. (auth)

**32928** (TID-13293) FUEL CYCLE COSTS FOR SPECIFIC POWER REACTORS. Donald W. Kuhn and Ray D. Walton, Jr. (Office of Operations Analysis and Forecasting, AEC). July 1961. 30p.

Fuel cycle costs were calculated for the following power reactors: Dresden, Bonus (Puerto Rico), Hallam, Yankee, Carolinas-Virginia (Parr Shoals), and Piqua. (D.L.C.)

**32929** (TID-13902) AN ANALOG SOLUTION OF THE SEISMIC VIBRATIONS OF A GAS COOLED REACTOR. M. W. Milligan (Tennessee. Univ., Knoxville. Engineering Experiment Station). July 1961. For Oak Ridge National Lab. Contract [W-7405-Eng-26], Subcontract 875. 67p. (ME-61-TNI)

A gas-cooled reactor is considered that consists of a pressure vessel mounted on a skirt, which rests on the earth. The lateral displacements of the skirt and the fuel rods, and the angular displacement of the pressure vessel, are found as functions of time ( $t$ ) for various lateral earth movements  $S(t)$ . Calculations are shown for the cases in which  $S(t)$  is a step function, a cosine function at 5 to 20 cps, or a "damped sine" function at 5 to 20 cps. The "damped sine" function closely simulates actual earthquake disturbances. (T.F.H.)

**32930** THE TECHNICAL UTILIZATION OF NUCLEAR ENERGY. A. Weckesser (Atomkraftwerk Kahl G.m.b.H., Kahl am Main, Ger.). Atom u. Strom, 7: 49-52 (July 1961). (In German)

At the present time no other method exists for the utilization of nuclear energy than its transfer into heat and its application in this form. Some basic problems in the development of reactors are briefly surveyed. The effect of the fuel material, development and testing of new construction materials, the fuel element as a heat transfer agent, and the construction of reactors are the questions considered. (J.S.R.)

**32931** GENERAL FORMULATION OF THE THERMAL UTILIZATION FACTOR. R. Bonalumi (CISE, [Milan]). Energia nucleare (Milan), 8: 535-6 (Aug. 1961). (In English)

A straightforward application of the first collision probabilities to fine flux calculations and evaluation of the thermal utilization factor in a reactor cell are presented. The problem consists of a cell of an infinite reactor: if  $m$  regions constitute the cell, let the outermost region be the  $m^{\text{th}}$  and be occupied by moderator. (N.W.R.)

**32932** FLOW RESISTANCE AND HEAT TRANSFER IN ANNULAR FISSIONS WITH ROUGH NUCLEAR TUBES. H. Brauer (Forschungsinstitut der Mannesmann A.G., Duisburg, Ger.). Kerntechnik, 3: 387-91 (Sept. 1961). (In German)

Investigations on the flow resistance and the heat transfer in annular fission tubes were performed whereby the center tube located concentrically within the covering tube was heated electrically. The center tubes used had various diameters and smooth or rough surfaces, the roughnesses consisting of groove-like depressions and ribbed elevations. The tests were performed with water so that the Prandtl number remained constant. The range of the Reynolds number extended from  $\text{Re} = 2 \times 10^2$  to  $10^5$ , which covered both laminar as well as turbulent flow range. The test results were presented in nondimensional form. (auth)

**32933** REACTORS. VOLUME 2. H. R. McK. Hyder, ed. Progress in Nuclear Energy. Series II. New York, Pergamon Press, 1961. 374p.

Sixteen papers are included on the characteristics, performance, operation, and principles of various reactors. Both theoretical and experimental studies are made. (N.W.R.)

**32934** IMPROVEMENTS IN AND RELATING TO CORE STRUCTURES FOR HETEROGENEOUS NUCLEAR REACTORS. Michael Carl Hartnell-Beavis (to General Electric Co., Ltd.). British Patent 878,506. Oct. 4, 1961.

An improved and simplified reactor core construction is described which should lead to simplification of the charging and discharging operations. The core is designed so that fuel channels are disposed in unit areas symmetrical about regions which are clear of fuel channels. The core design is suitable for use in gas-cooled reactors of high output. (D.L.C.)

**32935** IMPROVEMENTS IN NUCLEAR REACTOR POWER MONITOR. (to General Electric Co.). British Patent 878,536. Oct. 4, 1961.

An improved method and apparatus for determining the relative power and power distribution throughout a reactor core are described which eliminates pressure vessel penetrations, placement of foreign materials in the reactor, and interference with reactor operation. In this method, the radiation emitted from the core is collimated and detected at a point remote from the core; the power level is indicated by the amount of attenuation of the radiation, which is inversely proportional to the coolant temperature. The radiation to be collimated preferably is emitted from one end of a coolant flow channel. (D.L.C.)

**32936** IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. John Godfrey Morley and Campbell Dean Boadle (to Rolls-Royce Ltd.). British Patent 878,872. Oct. 4, 1961.

A reactor fuel element is described which comprises a vitrified glass-forming composition consisting of  $\text{SiO}_2$  in a major proportion, a fissile material dispersed in the vitrified composition in a proportion of up to 10 wt %, and oxides of Al, Mg, Pb, Zr, Na, and/or K. The composition has a melting point below the temperature at which the fuel element is operated in the reactor so that the composition is in a plastic state in the reactor. Some of the advantages of the composition are simpler fuel element shape, operation at high temperatures, improved heat transfer to the casing, retention of fission products, corrosion and oxidation resistance, and damage self-healing. (D.L.C.)

**32937** IMPROVEMENTS IN OR RELATING TO FUEL HANDLING ARRANGEMENTS FOR NUCLEAR REACTORS. Douglas Edward Anderson (to General Electric Co., Ltd.). British Patent 878,881. Oct. 4, 1961.

A fuel handling machine is designed so that it is compact and its height is not greater than that necessary for the accommodation of the actuating mechanisms. The machine includes a fuel feeding duct and a magazine of a plurality of compartments so arranged that only one end of each compartment can be brought into a feeding position, the other end remaining off the fuel feeding axis. In this way, storage room is provided on the fuel feeding axis for the actuating mechanisms. (D.L.C.)

**32938** IMPROVEMENTS IN OR RELATING TO FLEXIBLE FLUID SUPPLY ARRANGEMENTS. John Edward Hallett (to General Electric Co., Ltd.). British Patent 878,882. Oct. 4, 1961.

A flexible arrangement is designed for maintaining fluid supply between two members requiring substantial relative

angular movement. The arrangement comprises metallic tubing coiled a plurality of times around the axis of the angular movement and having its ends anchored respectively to the members. The apparatus is particularly applicable to a reactor charging and discharging machine containing a fuel feeding duct which is rotated to select and mate with a fuel channel and contains devices actuated by compressed gas. (D.L.C.)

**32939** IMPROVEMENTS IN NUCLEAR FUEL. (to General Electric Co.). British Patent 878,911. Oct. 4, 1961.

A  $\text{UO}_2$  fuel composition having a thermal conductivity higher than that of previous  $\text{UO}_2$  fuels may be made by dispersing  $\text{UO}_2$  particles in a matrix of BeO or SiC amounting to 25 to 40 vol % of the composition. (D.L.C.)

**32940** IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL MATERIALS. Roy Alfred Ulfsketel Huddle (to United Kingdom Atomic Energy Authority). British Patent 878,927. Oct. 4, 1961.

A process is outlined for producing pyrolytic carbon-coated carbide particles of a fissile metal. The process comprises contacting carbide particles with a hydrocarbon gas at a temperature above that at which carbon is deposited pyrolytically on the particles and below that at which excessive gas phase polymerization occurs. The hydrocarbon gas may be propane or benzene. Examples of the process are given for uranium carbide particles. (D.L.C.)

**32941** IMPROVEMENTS IN AND RELATING TO REFUELLING CARRIAGES FOR NUCLEAR REACTORS. (to Maschinenfabrik Augsburg-Nürnberg A. G.). British Patent 878,929. Oct. 4, 1961.

A fueling carriage is designed for precise alignment with fuel rod charging openings in the reactor shield. The carriage comprises an undercarriage supporting a traversing upper carriage, both being equipped with motor-actuated bolts adapted to engage holes in locating rails. A mechanical or electrical counter is associated with the locating rails to indicate the holes in register with the bolts. (D.L.C.)

**32942** IMPROVEMENTS IN OR RELATING TO SUPPORT MEANS FOR NUCLEAR REACTORS. Norman Thomas Barrett and Dennis Ross Poulter (to United Kingdom Atomic Energy Authority). British Patent 878,940. Oct. 4, 1961.

A reactor installation is designed in which the core containment vessel is supported in such a way that less complex stresses occur with temperature changes. The vessel is suspended from a flange member which is freely supported for radial expansion on a ground support via a series of rollers, and the core is carried on a grid supported by hangers from the flange member. The flange member is a ring torsion beam. An embodiment of the invention using liquid sodium coolant is described. (D.L.C.)

**32943** IMPROVEMENTS RELATING TO NUCLEAR REACTORS. Winnett Boyd (to Winnett Boyd Ltd.). British Patent 879,183. Oct. 4, 1961.

A gas-cooled, graphite-moderated reactor is designed for high-temperature operation. The reactor has horizontal fuel channels combined with vertical coolant passages, enabling ceramic fuel elements to be used. The reactor moderator is arranged for minimum Wigner growth. (D.L.C.)

**32944** IMPROVEMENTS IN LUBRICATION WITH SOLID LUBRICANTS. (to A.E.I.-John Thompson Nuclear Energy Co., Ltd.). French Patent 1,199,839. June 22, 1961.

The lubrication of control rod actuators and charge and



discharge gear of reactors by means of solid, profiled lubricators which are abraded by the surface that is to be lubricated is described. The lubricator consists of a molded body of graphite or Mo-, W-, or Ti- disulfide, -diselenide, or ditelluride (particle size 1 to 20 micron) and a synthetic resin, preferably Araldite 985 E, 961 A or 15. (NPO)

**32945** FISSION MASS IN CIRCULATION. (to Esso Research and Engineering). French Patent 1,202,926. Jan. 14, 1960.

A reaction process is described for a reactor, wherein a homogeneous fluid composition of fissionable material is passed through a flow path and a reaction zone; a sustained reaction is maintained in this zone. The cross-sectional area of a portion of the flow path is equal to the cross-sectional area of the reaction zone. An absorbing material having a capture cross-section above 10 barns per atom for neutrons with an energy range of 0.025 to 2.5 ev is positioned in neutron absorbing relationship in the flow path to maintain a subcritical condition. Preferably a neutron reflector or a chemical processing zone is disposed about the reaction zone. The chemical processing zone is formed by a processing chamber adapted to contain flowing organic material undergoing neutron irradiation. (NPO)

**32946** NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,203,458. Jan. 19, 1960.

A liquid moderated, gas cooled reactor comprises a cylindrical reactor tank positioned with its axis horizontal and a series of tubular channels passing through this tank parallel to the axis. Fuel cells, one to each channel, reach into the channels from either side, each cell comprising an outer tube closed at the end situated in the tank and an inner tube in which the fuel elements are placed. The coolant enters the annular interspace bounded by the two tubes and then flows back through the inner tube. Each fuel cell is connected at the side where it enters the reactor with both the entrance coolant header and the exit coolant header. The fuel cells form two groups, the cells of the same group entering the reactor from the same side. The channels occupied by the cells of the same group form a square lattice with a lattice spacing of  $LV_2$ , where  $L$  is the lattice spacing of the group formed by all the cells. (NPO)

**32947** METHOD AND DEVICE FOR DECONTAMINATING HEAT EXCHANGERS THAT ARE CONNECTED WITH NUCLEAR REACTORS. (to Société Parisienne de Constructions). French Patent 1,204,415. Aug. 10, 1959.

The contaminated surfaces of heat exchangers are rinsed with condensing steam. (NPO)

**32948** IMPROVEMENTS RELATING TO NUCLEAR REACTOR CORES. (to U. S. Atomic Energy Commission). French Patent 1,206,698. Feb. 11, 1960.

The core of a reactor comprises a plurality of parallelly positioned contiguous moderator elements, the fuel elements being arranged at the edges of the moderator elements. The moderator elements have a polygonal cross section, with a sector of a circle cut away at the corners or at the side faces in order to provide, with the adjacent elements, a cylindrical channel in which the fuel elements are arranged. The moderator elements are suitably of graphite having a hexagonal cross section and are clad with a corrosion resistant sheet, such as stainless steel, zirconium, titanium, or inconel. The fuel elements may form an assembly in each channel and comprise uranium enriched in  $U^{235}$ . The head of each moderator assembly may form a pyramid enclosing a gas absorbing material. (NPO)

**32949** QUASI HOMOGENEOUS NUCLEAR REACTOR.

Kurt Kiebnier. French Patent 1,207,342. Feb. 16, 1960.

A quasi homogeneous reactor comprises a reactor tank filled with cylindrically shaped, hollow bodies enclosing fuel and similarly bodies enclosing a moderator. A coolant circulates in the interspaces between the bodies. Each hollow body enclosing the fuel comprises a cylindrical layer of fuel clad with a metal or non-metal layer protecting it against corrosion. The fuel may be composed of a ceramic substance that is homogeneously mixed with the fissionable material, the whole being covered with a supplementary ceramic layer that prevents escape of fission products into the coolant. In another form the hollow fuel bodies are constituted by uranium carbide, with or without a protecting layer. (NPO)

**32950** NUCLEAR REACTOR. (to General Dynamics Corp.). French Patent 1,208,408. Feb. 23, 1960.

The core of a reactor is formed of one or more bodies of substantially non-porous material comprising a homogeneous mixture of fissionable material and a solid moderator, so that the neutron temperature will increase simultaneously with an increase in moderator temperature. The reactor core may also have a homogeneous admixture of a material having a high neutron capture cross section distributed within the reactor in such a manner that the absorption of neutrons by this material relative to the absorption of neutrons by the fissionable material increases with temperature. Suitably this material has a large number of strong resonance absorption bands at energies above thermal, the concentration of this material in the moderator being such that at least 3 per cent of the neutrons are captured by resonance absorption. Preferably the reactor comprises a plurality of tubes, filled with the homogeneous mixture of solid moderator and fissionable material, projecting into the coolant within a reactor tank, the tubes being spaced to provide passageways for the coolant circulation in the tank. (NPO)

**32951** IMPROVEMENTS RELATING TO GRAPHITE MODERATOR STRUCTURES FOR NUCLEAR REACTORS. (to Showa Denko Kabushiki Kaisha). French Patent 1,209,950. Mar. 4, 1960.

In a graphite moderator structure, comprising layers of vertically positioned graphite blocks of square cross section and provided with axial cylindrical coolant channels, the ends of the blocks in adjacent layers are separated by a layer of square graphite tiles in which the blocks are fitted. The blocks are provided at their upper and lower ends with keys or protruding portions extending in one direction and, at about the same level, with keyways or channelled portions extending in a direction at right angles thereto; the arrangement is such that the keys and keyways at the lower end are in directions perpendicular to those at the upper end of each block. The graphite tiles are provided with keys and keyways along the opposite edges of both the top and bottom faces. The width of the keys and keyways of the tiles is one half the width of those formed on the graphite blocks, so that always two keys of adjacent tiles slide parallelly in the same keyway of a graphite block, each tile being in connection with eight blocks. Each tile is further cut away at the four corners to form a  $90^\circ$  sector of a circle to provide at the meeting corners of any four tiles a cylindrical opening for axial alignment with the coolant channel in the graphite blocks. (NPO)

**32952** NUCLEAR REACTOR. (to English Electric Co., Ltd.). French Patent 1,211,295. Mar. 15, 1960.

Retaining means are described for the core structure of a reactor able to withstand earthquake shocks. The core

structure, comprising a pile of layers of vertically positioned graphite blocks, each layer being separated from the succeeding layer by layers of graphite tiles keyed to the graphite blocks, is held together by retaining means comprising a series of retaining belts enclosing the core structure at different levels. Each belt is composed of a plurality of links joined together at their ends by joining pins; each joining pin is fixed to the inner end of a radially extending organ having its outer end jointed at the outer corner of a triangular piece, the two inner corners thereof each being fitted to one of two adjacent pieces each having a U-shaped cross section and surrounding one of the links on three sides, without touching it. The surface of the piece corresponding to the base of the U is pressed against a vertical side face of the core structure. The fitting of the triangular pieces is effected by pins mounted therein and each sliding in a longitudinal slot provided in the side wall of the adjacent U-shaped piece. Each of the U-shaped pieces is provided with a radially extending keying bar that is movable in a slide in an outer rigid structure, which supports the keying bars for all the retaining belts. This outer structure encloses the core, leaving an interspace between it and the surface of the core and resting with its lower extremity on the core support. (NPO)

**32953** NUCLEAR REACTOR. (to English Electric Co., Ltd.). French Patent 1,212,620. Mar. 24, 1960.

Retaining means for the core structure of a reactor able to withstand earthquake shocks or the temporary accelerating forces in a reactor mounted on a ship are described. These retaining means, able to apply centripetal forces to the core structure, are arranged around this structure, spaced from each other. These retaining means comprise retaining belts each positioned one above the other, each belt being composed of a plurality of links joined together at the ends by joining means, and supporting the organs designed to apply the centripetal forces. Each of these belts is connected to the core supporting grid through an encircling structure spaced from the core. This encircling structure is provided with guiding organs that allow each of the joining means a radial displacement. (NPO)

**32954** NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,213,002. Mar. 28, 1960.

In a graphite structure of a reactor, comprising a pile of layers of vertically positioned graphite blocks provided with axial coolant channels, the side faces of these blocks are hollowed out over the greatest part of their length, so that adjacent blocks are only in contact over narrow strips at the upper and lower ends of the side faces. The structure comprises retaining organs to press the blocks together centripetally at the level of these strips. The ends of the blocks are provided with interlocking means for keeping the coolant channels of succeeding blocks connected, even in case of a deviation of alignment of the channels caused by the difference in Wigner growth of succeeding layers of blocks. (NPO)

**32955** IMPROVEMENTS RELATING TO STAYS FOR SUPPORTING TWO SUPERPOSED LOADS MOVABLE RELATIVE TO EACH OTHER. (to Société des Forges et Ateliers du Creusot). French Patent 1,215,776. May 20, 1960.

An improvement is described for reactors with cores positioned inside pressure vessels. The supporting structure allows limited horizontal displacements of the core relative to the pressure vessel and of the vessel relative to sole pieces fixed on the ground. The core rests on a series of roller bearings, each comprising at least two

rollers and being supported on a ball that rests in the concave end of one of a series of rigid stays fixed to the pressure vessel wall. Each of these stays extends in a vertical direction outside the pressure vessel wall and rests on one of the sole pieces through a similar connecting ball and roller bearing. (NPO)

**32956** MEANS FOR IMPROVING THE EFFICACY OF THE REFLECTORS IN NUCLEAR REACTORS. (to A. G. für Unternehmungen der Eisen- und Stahlindustrie and Brown, Boveri & Cie A. G.). French Patent 1,222,910. Jan. 25, 1960.

The efficacy of the reflector is improved by maintaining it at a higher temperature than is customary. This can be achieved either by by-passing a part of the heated coolant through the reflector or by enveloping the reflector with a heat insulating layer. (NPO)

**32957** IMPROVEMENTS RELATING TO NUCLEAR REACTORS. (to General Electric Co., Ltd.). French Patent 1,223,772. June 20, 1960.

In a gas cooled reactor provided with vertical channels in the moderator, several fuel elements are stacked in each channel. Each fuel element consists of a graphite cylinder sliding in the channels with a clearance of about 1.5 mm and a clad fuel rod supported in the graphite cylinder. The clearance is often sufficient to allow an appreciable leakage of moderator between the rod and the cylinder. In order to prevent or limit this, a series of annular radial protruding lugs are provided one after the other on the upper part of the outer surface of the graphite cylinder, the downstream edge of each lug being beveled. (NPO)

**32958** MODERATOR CONTAINER FOR A HETEROGENEOUS NUCLEAR REACTOR WITH LIQUID MODERATOR. (to Siemens Schuckertwerke A. G.). French Patent 1,225,589. July 1, 1960.

In order to keep the temperature of the liquid moderator of a heterogeneous reactor below the temperature of the coolant, which is constituted by the same liquid, the reactor vessel encloses a cylindrical moderator container with a vertical axis and cooling tubes passing parallelly through this container. In the container two deflecting cylinders are positioned, coaxially with the container, one enclosing the other partly. Cold moderator liquid is fed from outside the reactor to the bottom of the inner cylinder, from where it rises to the top of the container, passes down through the interspace bounded by the two deflecting cylinders and then rises along the inner cylindrical wall of the container and enters the interspace formed between the reactor vessel and the outer wall of the container at openings in the container wall near its upper extremity. In this latter interspace the moderator is mixed with the coolant as it flows down and the mixture then rises through the cooling tubes and removes the heat developed in the fuel elements. (NPO)

**32959** METHOD AND DEVICE FOR ENSURING THE SAFETY OF NUCLEAR REACTORS IN PARTICULAR OF REACTORS COOLED BY CARBON DIOXIDE. L. Denis. French Patent 1,226,423. July 11, 1960.

In order to absorb the heat developed during a reactor accident, the coolant circuit of a carbon dioxide cooled reactor is provided with an auxiliary cooler built in a by-pass of the circuit. Any desired proportion of the circulating coolant can be led through this auxiliary cooler. The by-pass comprises a container with a bottom forming a reservoir for liquid carbon dioxide in a quantity equal to the amount of coolant in the reactor. The liquid carbon dioxide is obtained by condensation on the surface of cooling elements passing through the container, and falls from the elements into the reservoir. These cooling elements



are fed by a pump with a refrigerating liquid stored in a second container. (NPO)

**32960** NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,226,735. July 15, 1960.

A reactor core with a multitude of parallel cooling channels placed inside a pressure vessel is provided with end shields to avoid excessive activation of the pressure vessel space bounded by the shield and the pressure vessel wall, so that this part is accessible for maintenance purposes. The core and the shield are supported by a structure enabling them to be taken away as one unit. The shield protects the upper front face of the core. According to another form the vessel space may be flooded so that the shield and the core may be dismantled under water and taken away piece by piece. The shield is built up of alternate layers of graphite and steel. (NPO)

**32961** DEVICE FOR MEASURING THE TEMPERATURE INSIDE A NUCLEAR REACTOR. (to Compagnie Industrielle des Téléphones). French Patent 1,228,343. Aug. 29, 1960.

In order to measure the temperature inside a fuel element that is in position in the reactor channels, two conducting rings are provided for each fuel element in which the temperature is to be measured. These conducting rings are fitted in the wall of the channel with their contacting surfaces flush with the cylindrical surface of the channel. The two rings associated with a given fuel element are spaced one from the other at a distance corresponding to that between two series of contact brushes mounted on the fuel element at two levels and connected with the thermocouples inside the element. The brushes are arranged to protrude in radial directions as the fuel element comes to rest in its working position and are pressed against the conducting rings, which are in turn connected with the measuring instrument outside the reactor. (NPO)

**32962** DETECTION OF ESCAPES FROM NUCLEAR FUEL ELEMENTS. (to General Electric Co.). French Patent 1,228,525. Aug. 31, 1960.

In a reactor, a vapor phase fraction containing all rare gas fission products that may have escaped is separated from the coolant flowing in close contact with the fuel elements. This vapor phase fraction is brought into contact with a solid that adsorbs the radioactive decay products. Strontium or yttrium arising from krypton and barium or lanthanum arising from xenon is representative of the radioactivity as a whole. For testing the adsorbent, a separation grid is provided above the upper ends of the fuel elements where the coolant leaves the fuel element channels, this grid supports a liquid-vapor separator above each coolant exit. Each of these separators is connected with an individual adsorber tube by a connecting tube. The adsorber tubes are grouped and assembled in a basket positioned in a closed container inside the reactor pressure vessel, so that the basket may be removed as a unit for testing the adsorbents during a shut-down of the reactor. (NPO)

**32963** IMPROVEMENTS RELATING TO NUCLEAR REACTORS, IN PARTICULAR TO HOMOGENEOUS GAS COOLED REACTORS. (to Société d'Exploitation des Matériels Hispano-Suiza). French Patent 1,230,018. Sept. 13, 1960.

A means is described for charging or discharging the fuel elements in a homogeneous gas cooled reactor. The vertical reactor channels are grouped, so that each group is served by a charging arm reaching any channel of the group. Each of these charging arms is positioned in a vertical tubular charging chute passing through the biological shielding situated above the reactor vessel and through the pressure

vessel wall. This arm is connected above the shield to a remote control head enclosing means for controlling the different movements of the arm. The head is removable so that it can be connected with any one of the charging arms. A second shielding is placed above the space within which the head can move, this shielding being provided with openings in alignment with the different lower charging chutes, upper charging chutes passing through these openings. The remote control heat container is gas tight and able to withstand the same working pressure as the reactor pressure vessel, which is in communication with the container. (NPO)

**32964** FUEL ELEMENTS FOR NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,232,668. Oct. 11, 1960.

In order to measure the temperature inside each of a series of fuel elements, stacked one upon the other in vertical reactor channels, each element comprises at both ends contact means able to effect electrical contact with the corresponding contact means of the adjacent end of the succeeding fuel element. The fuel elements each have at their upper ends a number of concentric contact rings provided at the same level and at their lower ends eccentrically positioned contact means able to make contact with the contact rings of the next lower fuel element. One of the upper contact rings of each fuel element is connected with the hot junction of a thermocouple situated in this element, each of the other rings being connected with corresponding contact means at the lower end of the same fuel element by cables passing through the fuel element body, so that each of the hot junctions of the thermocouples of all the lower positioned fuel elements is connected with one of the contact rings of the uppermost fuel element. Contact means are provided to connect these latter contact rings, and thus all the thermocouple junctions, with the measuring instruments. (NPO)

**32965** FUEL ELEMENT FOR NUCLEAR REACTOR, PROVIDED WITH A MEANS TO REVEAL A PHYSICAL STATE. (to United Kingdom Atomic Energy Authority). French Patent 1,239,110. July 11, 1960.

A canned fuel element is interiorly or exteriorly provided with a capsule which contains material that undergoes a physical change during the operation of the reactor. The capsule can contain a disc of cobalt, the radioactivity of which is measured after removal from the reactor and is a measure of the amount of radiation the fuel element has received. A second possibility is to fill the capsule partly with a material that melts at a given temperature (5 to 10% B or BC in Al; m.p. 660°C); deformation of this material indicates that the fuel element has exceeded the set temperature limit. (NPO)

**32966** FUEL ELEMENTS. (to Babcock & Wilcox Co.). French Patent 1,239,253. July 11, 1960.

The application of helical springs as longitudinally extending spacers in fuel rod assemblies is described. (NPO)

**32967** BOILING WATER REACTOR. (to General Electric Co.). French Patent 1,241,339. Aug. 8, 1960.

In a boiling water reactor the creation of steam bubbles during the operation induces a different depletion of fuel in the different core zones as a result of the different average moderator density caused by the steam bubbles. In order to avoid excessive differences in depletion of the fuel, the fuel elements have an elongated form, so that the average total amount of fuel (fissile and fertile) decreases along the element axis in the direction of flow of the boiling water through the core. The fuel element is provided with a uniform amount of fissile material per unit length. The local multiplication factor  $K_{eff}$  is held constant in this way along the path of the boiling water flow. (NPO)

**32968** REACTOR CORE COMPOSITION FOR OBTAINING A FLATTENED FLUX. (to U. S. Atomic Energy Commission). French Patent 1,249,178. Nov. 14, 1960.

In order to obtain a flattened flux the moderator is composed of separate elements which consist of two moderating substances that possess a different Fermi age. The proportion of the two substances varies from the center to the periphery of the core in such a manner that the concentration of the substance with the lower Fermi age increases and the composite Fermi age follows a cosine function. Suitable mixtures are Be or BeO and graphite, hydrogen and deuterium, graphite and deuterium or oxygen. (NPO)

**32969** FUEL STRUCTURE FOR NUCLEAR REACTOR. (to Sylvania Corning Nuclear Corp.). French Patent 1,249,436. Nov. 21, 1960.

The construction of a fuel element which consists of an assembly of coaxial cylindrical or polygonal spaced fuel plates around a central support tube is described. (NPO)

**32970** IMPROVEMENTS IN METHODS FOR THE FIXATION OF ELEMENTS IN A TUBULAR SPACE, ESPECIALLY IN NUCLEAR REACTORS. (to Commissariat à l'Energie Atomique). French Patent 1,249,487. Nov. 21, 1960.

A fuel element which consists of an assembly of superposed fuel containers or clusters of interconnected fuel rods in a tubular jacket is described. Each container or cluster is provided at the top with a rotatable locking device that engages in a support ring which is pinched in the jacket. (NPO)

**32971** METHOD OF PURIFYING GASES THAT CIRCULATE IN GAS COOLED REACTORS. (to Beteteiligungs- und Patentverwaltungsgesellschaft m.b.H. and Brown, Boveri & Cie A. G.). French Patent 1,250,176. Nov. 28, 1960.

Gaseous reactor coolants are continuously purified by introducing an adsorbing dust (particle size 0.1 to 10 micron), such as graphite dust, in the main stream, maintaining the dust content constant at 100 g/m<sup>3</sup>, and filtering off a part of the adsorbent in a by-pass. In graphite moderated reactors the dust originating by erosion of the moderator can be utilized. (NPO)

**32972** IMPROVEMENTS IN MODERATORS AND COOLANTS FOR NUCLEAR REACTORS. (to Commissariat à l'Energie Atomique and Institut Français du Pétrole, des Carburants et Lubrifiants). French Patent 1,252,177. Dec. 19, 1960.

The application of highly aromatic petroleum fractions or coal distillates, boiling above 300 to 350°C, is proposed as cheap and radiation resistant moderators and coolants that possess satisfactory thermal stability, good fluidity, low volatility and viscosity, and no corrosive properties. Suitable fractions are aromatic extracts from lubricating oils, heavy fractions resulting from hydroforming, cracking, hydrodesulfurization, polymerization, alkylation, or isomerization treatments, and many others. The radiation resistance of these fractions can be improved by a preliminary irradiation with neutrons, gamma rays, or electrons. (NPO)

**32973** IMPROVED NUCLEAR FUEL ELEMENTS. (to Société Nationale d'Etude et de Construction de Moteurs d'Aviation). French Patent 1,252,674. Dec. 26, 1960.

Regular assemblies of fuel rods or coaxial fuel tubes are described. In order to establish a uniform heat flux per unit surface the concentration of fissile material increases from the periphery to the center of the assembly. The cross section can likewise increase in the same direction. The peripheral rods may consist of 40% UO<sub>2</sub> and 60% MgO, the central rod of 48% UO<sub>2</sub> and 52% MgO. (NPO)

## Power Reactors

**32974** (APEX-617) LAB PLATE-OUT STUDY I; SPECIAL LOOPS INSTALLED IN CTF DURING IET 21 AND 25. M. N. Myers (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Apr. 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 50p.

A study was undertaken to provide information on the quantitative plate-out, or deposition of fission products on hardware and effluent sampling lines in the various reactor systems. The effect of temperature, flow, bends, and fittings was studied. The retention efficiency of coconut charcoal traps for radioiodine, radiobarium and radiostrontium isotopes was also measured. (auth)

**32975** (CEND-117) NUSU STEAM PURITY TESTS. V. C. Hall, Jr., J. S. Hucks, and R. C. Brayer (Combustion Engineering, Inc. Nuclear Div., Windsor, Conn.). Jan. 1961. Contract AT(11-1)-795. 61p.

The NUSU steam purity tests were conducted to determine the degree of steam purity required for an integral boiler-superheater nuclear reactor. The design parameters of an out-of-pile test loop are described. The semi-quantitative results obtained from the operation of the test loop are presented. It is recommended that an additional series of tests be initiated to provide additional design information for integral boiler-superheater type reactor systems. (auth)

**32976** (DLCS-3770101) EFFECT OF STEAM GENERATOR PERFORMANCE ON CORE POWER DISTRIBUTION. Test Evaluation. (Duquesne Light Co., Shippingport, Penna.). First issue, Oct. 5, 1961. 67p.

Tests were carried out to determine the effect on core power distribution of varying the relative heat output of the steam generators with constant reactor and plant load. Nuclear instrumentation readings were taken for four hours after equilibrium xenon was reached. A thermal analysis based on core  $\Delta T$ 's at 20% power level, as well as nuclear instrumentation data, indicated that steam generator performance has little effect on core power distribution. However, a thermal analysis at 40% power level did not agree with data or the analysis at 20%. (M.C.G.)

**32977** (GA-2204) 40-MW(E) PROTOTYPE HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report, January 1, 1961–March 31, 1961. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Contract AT(04-3)-314. 196p.

Summary research and development studies directed toward the construction of a 40-Mw(e) prototype power plant employing a high-temperature, gas-cooled, graphite-moderated reactor (HTGR) are described. These include: the development of pyrolytic coating of carbide particles to a point of scaleup for production purposes; the development of nondestructive testing methods for graphite tubes; the assembly of a 4-ft-long element, together with a backup element, for in-pile testing; and the evaluation of low-permeability graphite samples after an irradiation to approximately 10<sup>21</sup> nvt to 1400°C. Other accomplishments include the first preliminary successful results on the production of U–Th carbides, on a laboratory scale, and production of 4-ft lengths of graphite tubes. The most striking irradiation effects on impermeable graphites which were evaluated concern the relatively large degree of contraction observed on several samples. Installation of the in-pile loop at the General Electric Test Reactor is essentially complete. The main loop and the fission-product



trapping and sampling systems have been leak-checked. Two fully rated circulators have been installed in the loop and have been run for approximately 5 hr each. Work on the development of codes for nuclear calculations continued with the completion of a one-dimensional burnup program designated FEVER and the final checkout and use of the two-dimensional code DDB. The half-scale flow model was assembled, instrumented, and checked out. Heat-transfer, flow, and pressure data have been taken, and reduction and analysis are under way. The total pressure drop of the prototype HTGR has been calculated based on flow-model results. Studies on the pressure vessel and internals have included methods for emergency cooling of the vessel, analyses of neutron streaming out of the concentric nozzles, and attestation of the outlet gas following a loss-of-pressure accident. The design of the rocker-arm reflector is continuing with studies on the linkage mechanism and the vertical seals. The soundness of the principle of holding the core together by the gas pressure on the outer surface of the reflector blocks has been established in tests with the half-scale flow model. Results obtained from tests on structural materials in helium contaminated with  $H_2$  and CO indicate that oxidation rather than carburization appears to be the major corrosion process influencing the materials studied. The design of the prototype control rod and drive was completed, and fabrication of the components for the rod and drive system is essentially complete. A flow model of the concentric pipe was designed and built to obtain heat-transfer and pressure-drop data. A simulated fuel compact containing coated fuel particles was irradiated to an exposure equivalent to about three years in the HTGR. The release characteristics of the irradiated compact showed evidence that a majority of the particles were still intact. Experiments were initiated to study the steady-state release of the short-lived isotopes of krypton and xenon. Studies on a coolant monitoring system and a failed-fuel-element location system were completed. An operational analysis effort was initiated to determine in detail the operational aspects of the plant during normal and abnormal operating conditions. Intensive studies on safety and hazards were made: of core oxidation resulting from the admittance of air following a rupture of the main coolant system; the transient differential pressures across internal components and the pressure increase in the plant container during blow-down following rupture; and the adiabatic pressure peak in the containment shell caused by ruptures in either the coolant system or the steam generator, or both. Design studies included emergency isolation of the primary loops, emergency cooling of the pressure vessel, and emergency shutdown systems. (auth)

**32978** (GA-2283) A REVIEW OF FUEL ELEMENT RESEARCH AND DEVELOPMENT FOR THE HIGH TEMPERATURE HELIUM GAS-COOLED REACTORS. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). June 8, 1961. Contract AT(04-3)-314. 42p.

Presented at the 6th Nuclear Congress organized by the C.N.E.N. in Rome, Italy, June 13-18, 1961.

The development of fuel elements for high-temperature gas-cooled reactors is reviewed. The elements consist of graphite jackets containing  $(Th,U)C_2$  compacts. Methods for preparing  $(Th,U)C_2$  particles are described, and results are given for out-of-pile and in-pile tests of fuel elements. Emphasis is on retention of fission products. (D.L.C.)

**32979** (GEAP-3724) NUCLEAR SUPERHEAT PROJECT SEVENTH QUARTERLY PROGRESS REPORT, JANUARY-MARCH 1961. R. T. Pennington (General

Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Contract AT(04-3)-189. 130p.

Progress and results from the conceptual design, economic evaluations, and research and development work performed as part of the Nuclear Superheat Project are reported. Developments in conceptual design and program evaluation, fuel technology, materials development, experimental physics, coolant chemistry, heat transfer, mechanical development, SADE, and mixed spectrum superheat design are discussed. (M.C.G.)

**32980** (GNEC-150) STEAM-COOLED POWER REACTOR EVALUATION. INTEGRAL NUCLEAR SUPERHEAT REACTORS. (General Nuclear Engineering Corp., Dunedin, Fla.). Apr. 30, 1961. Contract AT(11-1)-948. 464p.

A preliminary design study was made of a steam-cooled, integral nuclear-superheat reactor concept at three levels of operating power. The following preliminary design categories were covered: a 40-Mw(e) reactor plant for 1965, a 300-Mw(e) plant utilizing one reactor for 1967, and an alternate-design 300-Mw(e) plant utilizing two reactors for 1967. (M.C.G.)

**32981** (GNEC-172) NUCLEAR SUPERHEAT DEVELOPMENT PROGRAM. Seventh Quarterly Progress Report, January-March, 1961. (Combustion Engineering, Inc., Windsor, Conn.). Contract AT-(11-1)-795. 122p.

An alternate reactor arrangement was developed to permit the use of mechanical steam separators to supplement gravitational separation. An alternate NUSU reference design using annular multitube elements and a Hy-Ball control system is being worked up. Power flattening by Hy-Ball control systems was investigated in both the axial and radial directions. A preliminary investigation of the heat-transfer characteristics of annular multitube fuel elements was initiated, using the relaxation method. Criticality data collected for various cores containing double-annular fuel elements are presented for both flooded and voided conditions. An analytical method was developed which accurately predicts criticality, water-gap peaking, and power distribution for cores with both rod-type and double-annular elements. Test results of steam separators are described. A program for testing double-annular fuel elements is described. (D.L.C.)

**32982** (NAA-SR-6370) ANNUAL TECHNICAL PROGRESS REPORT, AEC UNCLASSIFIED PROGRAMS, FISCAL YEAR 1961. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 15, 1961. Contract AT(11-1)-Gen-8. 538p.

Progress is reported on the Advanced Sodium Cooled Reactor, Hallam Nuclear Power Facility research and development, Advanced Organic Moderated Reactor, Prototype Organic Power Reactor, reactor safety, separation chemistry, and advanced development program. (M.C.G.)

**32983** (NDA-2131-42) HEAVY WATER-MODERATED POWER REACTOR PROGRAM. Quarterly Progress Report for Period Ending September 30, 1961. (United Nuclear Corp. Development Div., White Plains, N. Y.). Sept. 30, 1961. Contract AT(30-1)-2836. 14p.

Reactivity measurements are reported for 37-rod clusters of 0.50-in.  $UO_2$  fuel rods, and preliminary data are also given for three lattice pitches of 31-rod clusters. Tests to be made on tubular  $UO_2$  fuel elements are described. (D.L.C.)

**32984** (NP-10766) SYMPOSIUM ON NUCLEAR POWER HELD AT BOMBAY ON JANUARY 17 AND 18, 1961. (India. Atomic Energy Commission, Bombay). 83p.

Included are nine papers discussing: a Canadian approach to nuclear power; design of heavy water reactors for neutron economy and thermal efficiency; the French atomic power program; a project for a heavy water moderated power reactor with heat extraction by gases under pressure; a fast neutron reactor in U.S.S.R.; nuclear power policies in the United Kingdom; British experience in the technical development of power reactors; reactor development in the United States; and the outlook for thorium as a long term nuclear fuel. Four papers were previously abstracted in *NSA*. Separate abstracts have been prepared for the five papers. (B.O.G.)

**32985** (NP-10766(p.23-7)) FRENCH ATOMIC POWER PROGRAMME. F. Perrin (France. Commissariat a l'Energie Atomique, [Paris]).

A summary discussion is presented of the development of a nuclear power program in France, which was begun in 1956 to produce power competitive with that from conventional fuels. The program was started because of the scarcity of the conventional fuels available, but the recent discoveries of oil and natural gas fields in the Sahara have relieved the immediate need for competitive nuclear power. The experience gained in the construction of reactors since 1956 is discussed. (B.O.G.)

**32986** (NP-10766(p.28-30)) PROJECT FOR A POWER REACTOR MODERATED BY HEAVY WATER WITH EXTRACTION OF HEAT BY GASES UNDER PRESSURE. J. Horowitz (France. Commissariat a l'Energie Atomique, [Paris]).

Discussions are included of the main design parameters of a 300 Mw(e) power generating station, and of the prototype EL 4 reactor. (B.O.G.)

**32987** (NP-10766(p.32-5)) FAST NEUTRON REACTORS IN THE U.S.S.R. O. D. Kazachovskii (Kazachovskii) (U.S.S.R.)

A summary discussion is given of work conducted toward developing fast neutron reactors in the U.S.S.R. The characteristics and the experience gained in the operation of the BR-5 reactor are described. The BR-5 reactor is plutonium-oxide-fueled, liquid-sodium-cooled, nickel-reflected, and has a maximum output of 5 Mw. Intended uses of this research reactor are outlined. (B.O.G.)

**32988** (NP-10766(p.56-61)) REACTOR DEVELOPMENT IN THE UNITED STATES. Robert E. Wilson (Atomic Energy Commission, Washington, D. C.).

The developments are discussed in terms of: development costs; scope of power reactor development; light water and organic-cooled systems; pressurized water reactors; boiling water reactors; nuclear superheat; organic-cooled and moderated reactors; liquid-metal cooled and gas-cooled systems; heavy water reactors; and advanced reactor concepts. (B.O.G.)

**32989** (NP-10766(p.62-9)) THE OUTLOOK FOR THORIUM AS A LONG-TERM NUCLEAR FUEL. Robert A. Charpie and Alvin M. Weinberg (Oak Ridge National Lab., Tenn.).

An examination is made of the use of thorium from a long-range view in which concern is largely for the problem of breeding in the thorium-233 cycle. General considerations are given of the incentive for breeding, of the relative merits of uranium and thorium, and of fast and thermal breeders. A technical assessment is made of certain thorium breeder systems. The prospects for large scale utilization of thorium are considered good because: adequate high-grade thorium deposits are available to provide the inventory for starting a large power station;

thorium can be extracted from low-grade ores at a cost to provide fuel for an asymptotic energy system based on thermal breeder; good technical progress has been made in reactor developments; and significant progress is being made on the problem of finding a satisfactory method for ultimate waste disposal. (B.O.G.)

**32990** (ORO-411) SMALL SIZE PRESSURIZED WATER REACTOR, JAMESTOWN, NEW YORK, SITE REPORT. Includes Supplements 1, 2, and 3. (Gibbs and Hill, Inc., New York and Internuclear Co., Inc., Clayton, Mo.). 1960. 184p. Contract AT-(40-1)-2589.

The safety aspects of a small size pressurized water reactor power plant design are discussed, and the suitability of the Jamestown site for this plant type is treated in detail. (D.L.C.)

**32991** (SRO-59) HEAVY WATER POWER REACTOR PROGRAM MONTHLY PROGRESS REPORT [FOR] SEPTEMBER 1961. (Savannah River Operations Office, AEC). 15p.

Research and development is reported on the Halden III Proposal, the AEC-AECL Cooperative program, physics, engineering, and metallurgy. Progress in the design of the Heavy Water Components Test Reactor and in the Power Demonstration Program is summarized. (M.C.G.)

**32992** (TID-13685) MONTHLY OPERATING REPORT, SEPTEMBER 1960. (Duquesne Light Co., Shippingport, Penna.). Contract AT-11-1-292. 36p.

A summary of data on power output is given. Maintenance of reference water conditions in the reactor coolant system during the month is reported. Health physics problems arising during the month were associated with work being done in the BD purification cubicle. Personnel protective measures are discussed. A summary of maintenance activities is included along with a summary of tests and training activities. (J.R.D.)

**32993** (TID-13686) MONTHLY OPERATING REPORT, NOVEMBER 1960. (Duquesne Light Co., Shippingport, Penna.). Contract AT-11-1-292. 56p.

Station power level data are summarized for the month. Maintenance of reference water conditions in both the primary and auxiliary coolant water systems is reported. Plans for future refueling operations are discussed and general maintenance performed during the month is summarized. Tests and training activities are outlined. (J.R.D.)

**32994** (AEC-tr-4560) REACTOR G 1. (France. Commissariat a l'Energie Atomique, Paris). Translated from CEA Reports No. 670 "A" through CEA 670 "O". 375p.

This report was previously abstracted from the original language and appears in *NSA*, Vol. 12, as abstracts 6173-7 and 5619-28.

**32995** ECONOMIC CONSIDERATIONS OF NUCLEAR ENERGY. G. Leichtle (Referats für Kernenergie der Bayernwerk A. G., Munich). Atom u. Strom, 7: 52-5(July 1961). (In German)

Three of the principal factors in the cost of a nuclear reactor are construction costs, fuel element costs, and reactor operational time. Each of these factors is briefly discussed with a consideration of the effect of the reactor type and output on the total cost. (J.S.R.)

**32996** ASPECTS OF NUCLEAR NAVAL PROPULSION. Luigi Scaglione and Michele Patti (Istituto Nautico, Rome). Ing. nucleare, 4: 63-93(May-June 1961). (In Italian)

The main traits of nuclear energy as applied to naval propulsion in the merchant navy field are described, dedi-



cating particular attention to the problems of safety. After having briefly mentioned the requirements of merchant shipping and the advantages which might be offered by nuclear propulsion, the different types of reactors, which have been taken into consideration by studies, projects, experimental constructions, and by the first practical realization of naval engineering are examined. Safety problems are divided into the two main groups deriving from the inside and from the outside of the reactor. All of these problems are examined in detail insofar as their most important points are concerned. A survey is made of the economic problems of this type of propulsion. Present-day directives followed by the nations most active in this field are also mentioned. (auth)

**32997** WAYS OF STATIC CONVERSION OF NUCLEAR ENERGY. Ezio Betti and Giancarlo del Corso (CAMEN, Leghorn). *Ing. nucleare*, 4: 94-104 (May-June 1961). (In Italian)

Nuclear power static conversion methods, which use heat as an intermediate energy state, are reviewed. The thermoelectric method is studied in regards to the conversion efficiency obtainable, in theory, and to the conditions for which the efficiency is the highest. The thermoelectric efficiency of a semiconductor is drawn from the Boltzmann equation. (auth)

**32998** INDIAN POINT, CONSOLIDATED EDISON'S THORIUM CONVERTER. *Nuclear Eng.*, 6: 413-23 (Oct. 1961).

The Indian Point power station, located on the Hudson River 24 miles north of New York City, is described. The reactor is a thorium converter, and a considerable proportion of the output of the plant is obtained from fossil-fired superheat. The station has a gross electrical output of 275 Mw of which 112 Mw is produced from the oil-fired superheat. The pressurized water reactor has a gross thermal output of 585 Mw. Diagrams and descriptions are presented of the core, fuel elements, control rods, reactor, control rod drives, pressure vessel, primary coolant system, pressurizer, boilers, secondary circuit, plant control system, fuel handling system, containment and shielding, and auxiliary and supporting systems. (N.W.R.)

**32999** INSULATION ATTACHMENT BY WELDING FOR AN AIRCRAFT NUCLEAR PROPULSION POWER PLANT. (INVOLVES SPECIAL TECHNIQUES AND IS BEST CARRIED OUT WITH THE GAS TUNGSTEN-ARC SPOT-WELDING PROCESS). T. D. McLay and R. J. Campbell (General Electric Co., Cincinnati). *Welding J.* (N. Y.), 40: 1019-28 (Oct. 1961).

The data presented show that it is feasible and practical to weld individual sheet metal pad assemblies on the inside surface of the aft plug shield, combustor, header, and ducting of an aircraft nuclear power plant. The sheet metal assemblies hold fibrous thermal insulation which increases the service life of the covered material to several hundred hours and withstands service temperatures of 1600°F. The gas tungsten-arc spot-welding process gives greater reliability when employed for joining the insulation spacer to the structural wall, as compared to resistance and arc stud welding. The techniques and procedures could be applied to several different varieties of deep hole welding operations. (N.W.R.)

**33000** SMALL AND MEDIUM POWER REACTORS. VOLUME I. PROCEEDINGS OF THE CONFERENCE ON SMALL AND MEDIUM POWER REACTORS, SPONSORED BY THE INTERNATIONAL ATOMIC ENERGY AGENCY AND HELD AT VIENNA, 5-9 SEPTEMBER 1960. (International Atomic Energy Agency, Vienna). July 1961. 625p. (STI/PUB/30) \$9.00(IAEA).

A total of thirty-five papers are included for twenty-nine of which separate abstracts were prepared. Two papers appear in Russian with English abstracts and one in French with English abstract; the remainder are in English. The six papers previously abstracted in NSA were on nuclear power in Canada, The Maritime Gas-Cooled Reactor, The High Temperature Gas-cooled Reactor, operation of a small PWR, operating experience of the first USSR power plant, and operation of The Sodium Reactor Experiment. (J.R.D.)

**33001** IMPROVED BOILING-WATER REACTORS FOR SMALL AND MEDIUM SIZE NUCLEAR POWER GENERATING PLANTS. J. Williams and R. G. Lorraine (General Electric Co., San Jose, Calif.). p.15-35 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Significant technological improvements in natural circulation boiling-water reactor power plants (N-C BWR) are discussed. These power plants are designed for gross electrical output of 12,500 to 100,000 kw and should be of interest where demands are small but increasing, and where present generating costs are high. (J.R.D.)

**33002** THE 15 MWe NUCLEAR POWER STATION WITH BOILING-WATER REACTOR AT KAHL/MAIN—ITS CONSTRUCTION AND ITS POTENTIAL UTILIZATION IN DEVELOPING AREAS. H. J. Brüchner (Allgemeine Elektrizitäts-Gesellschaft Kernenergieanlagen, Frankfurt am Main). p.37-61 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Experience gained during construction of Germany's first nuclear power plant is reported. The plant is equipped with a light-water natural circulation boiling-water reactor operating in the indirect cycle and is designed to produce 15 Mw(e) during initial operation. A description of the power station is included along with a discussion of its possible uses. (J.R.D.)

**33003** 90 MWe INTERNAL NATURAL CIRCULATION BOILING-WATER REACTOR DESIGN STUDY. M. Matsumoto, K. Shimai, A. Oocki, T. Ebata, and T. Arai (Hitachi Works, Hitachi, Japan). p.63-78 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Design of an internal natural-circulation boiling-water reactor to produce 90 Mw(e) is described. Special emphasis is placed on compactness and economy. (J.R.D.)

**33004** USAEC NUCLEAR SUPERHEAT PROGRAMME. C. A. Pursel (Argonne National Lab., Ill.). p.83-110 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Developments in a U. S. program of research on power plants using superheated steam are discussed. The program is directed toward exploration of the economic potential and the technical feasibility of the superheat concept as applied to nuclear power plants which use saturated steam produced in a typical boiling-water core or in a section of such a core. (J.R.D.)

**33005** A NUCLEAR SUPERHEATING REACTOR: BORAX V. M. Novick and R. E. Rice (Argonne National Lab., Idaho Falls, Idaho). p.111-25 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Design and planned experimental uses for the Borax V reactor are summarized. (J.R.D.)

**33006** POTENTIAL OF THE USE OF HEAVY WATER IN POWER REACTORS. G. C. Laurence (Atomic Energy of Canada Ltd., Chalk River, Ont.). p.139-42 of "Small

and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

The future importance of heavy-water-moderated reactors is discussed. It is noted that the advantage of heavy-water reactors is greatest where fixed charges on capital investment are low and the load factor is high. Data on unit energy costs of a 20-Mw(e) NPD-type reactor up-rated to 50 Mw(e) are included. (J.R.D.)

**33007** A 50 MWe POWER-PRODUCING AND FUEL-TESTING NATURAL-URANIUM D<sub>2</sub>O REACTOR OF THE PRESSURE-VESSEL TYPE. A. Ziegler (Siemens-Schuckertwerke A. G., Erlangen, Ger.). p.143-64 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Design of a 50-Mw(e) fuel-testing power reactor using natural U and D<sub>2</sub>O as coolant-moderator is described. Included are physical and thermodynamic data and information on power costs. (J.R.D.)

**33008** THE SPECTRAL-SHIFT-CONTROL REACTOR (A VARIATION OF THE PWR). M. C. Edlund (Babcock and Wilcox Co., Lynchburg, Va.). p.165-78 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Design concepts for the Spectral-Shift Control Reactor are presented. The application of spectral-shift control to pressurized-water reactors ranging in size from 25 to 300 Mw(e) and their expected operating characteristics are also discussed. (J.R.D.)

**33009** THE CAROLINAS VIRGINIA TUBE REACTOR (CVTR). P. G. De Huff, E. C. Fiss, W. F. Eanes, and R. G. McGrath (Westinghouse Electrical Corp., Pittsburgh). p.179-93 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

A design description of the Carolinas Virginia Tube Reactor is presented. Objectives of the program are given along with reasons for selecting the pressure-tube, heavy-water-moderated and cooled design for development. (J.R.D.)

**33010** "BONUS"—A SMALL BOILING NUCLEAR SUPERHEATER POWER PLANT. J. M. West, F. Bevilacqua, and A. S. Jameson (General Nuclear Engineering Corp., Dunedin, Fla.). p.195-232 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

A description of the 17.3-Mw(e) boiling nuclear superheater (BONUS) power plant is given. A discussion on the role of this plant in the over-all development of nuclear superheat technology is included. (J.R.D.)

**33011** GENERAL FEATURES OF THE JAPAN POWER DEMONSTRATION REACTOR. K. Kubushiro, Y. Togo, and K. Mochizuki (Japan Atomic Energy Research Inst., Tokyo). p.233-47 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Descriptions are presented of the trend in Japanese energy resources, and the function of the 12.5-Mw(e) boiling-water Japan Power Demonstration Reactor (JPDR). General specifications are included along with discussions of special features and possible uses. (J.R.D.)

**33012** THE UNITED STATES ARMY NUCLEAR POWER PROGRAMME: ITS REACTORS AND THEIR APPLICATIONS TO LESS-DEVELOPED AREAS THROUGHOUT THE WORLD. J. K. Bratton (U. S. Atomic Energy Commission, Washington, D. C.). p.255-68 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

A program is described which is aimed at development of a variety of nuclear power plants to meet U. S. military requirements for electricity and heat at remote installations. The responsibilities for training military operators and provision of technical assistance to the Services is also discussed. Applications of this program in somewhat remote but developing regions are also examined. (J.R.D.)

**33013** HISTORY AND STATUS OF UNITED STATES SMALL POWER-PLANT PROGRAM AND SMALL PRESSURIZED-WATER REACTOR PROJECT. D. F. Cope and R. W. A. LeGassie (U. S. Atomic Energy Commission, Oak Ridge, Tenn.). p.269-82 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

The plans and activities concerning the small power plant program are summarized. Only government-owned reactors which provide steam for civilian co-operative power reactor demonstration projects in the U. S. and Puerto Rico are considered. Economic aspects of power production are examined. (J.R.D.)

**33014** IMPROVED PWR'S FOR SMALL AND MEDIUM POWER USE. J. H. Wright and A. R. Jones (Westinghouse Electric Corp., Pittsburgh). p.283-94 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

A concept is presented that illustrates the potential of the small closed-cycle pressurized-water reactor plant for improvement of cost reduction. (J.R.D.)

**33015** STATUS OF TECHNOLOGY FOR ORGANIC REACTOR POWER PLANTS. S. Siegel, W. E. Parkins, and C. A. Trilling (Atomics International, Canoga Park, Calif.). p.295-315 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

The development of the technology associated with power reactors cooled by organic liquids is reviewed. It is noted that great emphasis was placed on heat transfer rate measurements under various conditions. Development of fuels for use in organic coolants is discussed along with coolant purification systems. (J.R.D.)

**33016** AN ADVANCED MEDIUM-SIZED, ORGANIC-COOLED REACTOR (OCR) POWER PLANT. R. Balent, J. Brunings, and R. F. Wilson (Atomics International, Canoga Park, Calif.). p.317-38 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Design of the Organic-Cooled Reactor (OCR) power plant based on recent developments in organic reactor technology is described. Aluminum powder metals (6% Al<sub>2</sub>O<sub>3</sub>, 94% Al) are used to clad UO<sub>2</sub> thus producing a fuel element which exhibits high neutron economy, materials compatibility, long fuel life, and minimum fabrication cost. Design data for 75 to 100 Mw(e) plants are included. (J.R.D.)

**33017** DESIGN OF SMALL CENTRAL-STATION ORGANIC-REACTOR POWER PLANTS. E. F. Weisner, J. Jacobson, and C. W. Wheelock (Atomics International, Canoga Park, Calif.). p.339-48 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Design and operational plans for the Piqua Power Reactor are summarized. Extrapolation of the Piqua-type reactor to larger plants is discussed. (J.R.D.)

**33018** STUDY OF AN AUTOMATIC POWER-LEVEL CONTROL SYSTEM FOR A POWER REACTOR. M. E. Minashin, A. V. Bondarenko, Yu. A. Voznesenskii, I. I. Sidorova, and V. N. Sharapov. p.349-63 of "Small and Me-



dium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In Russian)

Aspects of automatic power-level control for power reactors are discussed. Included is the description of an example concerned with research on the transient processes of one type of reactor with such a control system. (J.R.D.)

**33019** DEVELOPMENT OF THE FRENCH GAS-REACTOR PROGRAMME AND APPLICATIONS TO MEDIUM POWER STATIONS. J. Bussac (Commissariat à l'Energie Atomique, Centre d'Etudes Nucleaires, Saclay, France). p.371-85 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In French)

An account of French experience in graphite-moderated, gas-cooled reactors is presented. The basis of the discussion is construction and operation of the G-2 and G-3 reactors. It is noted that techniques developed in France are based mainly on the use of natural U. It is also noted that recent developments appear to point to the possibility of improving the reactivity by recycling of reactor produced Pu. (J.R.D.)

**33020** AN ADVANCED GRAPHITE-MODERATED REACTOR SYSTEM FOR SMALL AND MEDIUM POWER OUTPUTS. M. Hartnell-Beavis, M. Lindfield, and T. Halsey (General Electric Co., Kent, England). p.387-416 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Developmental aspects of a gas-cooled graphite-moderated reactor design are presented in which uranium oxide fuel is used. Results of studies are included on an original 30-Mw(e) land-based design, an economic optimization of the 30 Mw(3) design which was extended to a 150-Mw(e) station, and an improved 30-Mw(e) installation. (J.R.D.)

**33021** DESIGN PHILOSOPHY OF THE AVR HIGH-TEMPERATURE REACTOR. A. Setzwein (Arbeitsgemeinschaft BBC-Krupp, Mannheim, Ger.). p.417-30 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Aspects of AVR high-temperature reactor design are discussed. It is noted that reactors of this design are well suited for export because of design and construction simplicity. The disadvantage of being limited in maximum power because of low specific output is considered of little importance in developing countries. (J.R.D.)

**33022** INTEGRAL NUCLEAR STEAM GENERATORS. W. R. Wootton (Babcock and Wilcox, Ltd., London). p.449-58 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Aspects of a design which unitizes reactor and heat exchangers in a pressure vessel are discussed. Possible variants of the basic principle are examined and a discussion on its application to small-size Calder Hall type reactors is included. (J.R.D.)

**33023** LPR—A 30-MW NATURAL-URANIUM NUCLEAR POWER STATION. D. Rudd (Humphreys and Glasgow Ltd., London) and R. E. Strickland. p.459-76 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

The design of a natural-U, gas-cooled reactor power station, operating at 60 psig with an installed capacity of 30 Mw is presented. It is noted that economic generation of electricity is attainable in such small stations at realistic load factors, using guaranteed burnup figures. (J.R.D.)

**33024** FOUR YEARS' OPERATING EXPERIENCE WITH THE CALDER HALL NUCLEAR POWER STATION.

T. Touhy and T. Marsham (United Kingdom Atomic Energy Authority, Windscale and Calder Works, Cumberland, Eng.). p.485-96 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

The operating experience is summarized in the areas of production performance, experimental work, plant safety, and plant staffing and training. Interpretation of the experience leads to the conclusion that the reactors should continue to operate for their expected life of 20 years at high load factors with an output of about 15% greater than expectations. (J.R.D.)

**33025** TECHNICAL SUPERVISION OF NUCLEAR POWER STATION CONSTRUCTION. L. B. Knowles and T. C. Leader (Merz and McLellan, Newcastle-upon-Tyne, Eng.). p.497-506 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Experience in nuclear power plant construction shows that higher demands are made on supervisory manpower than in comparable conventional work. Characteristics of nuclear power station construction are discussed and illustrated by items from Chapelcross construction experience. (J.R.D.)

**33026** CONSTRUCTION OF THE CHAPELCROSS WORKS OF THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY. A. E. Powell and L. B. Knowles (Merz and McLellan, Newcastle-upon-Tyne, Eng.). p.507-20 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

An account is given of methods used and experience gained on site in construction of the Chapelcross Nuclear Generating Station consisting of four gas-cooled graphite-moderated reactors, eight 23-Mw turbo-alternators, and auxiliary facilities. The scope includes only construction aspects. (J.R.D.)

**33027** OPERATION AND MAINTENANCE OF SMALL AND MEDIUM BWR PLANTS AS CONFIRMED BY VBWR EXPERIENCE. D. McDaniel and E. H. Van Zylstra (General Electric Co., San Jose, Calif.). p.521-36 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

A discussion is presented of startup, operation and maintenance of small and medium BWR plants on the basis of operation and maintenance of the Vallecitos BWR, and the Dresden experience where applicable to plants of this size. It is noted that experience gained in staffing, operating, and maintaining fossil-fired plants applies directly to nuclear plants. (J.R.D.)

**33028** MODIFICATIONS TO THE EBWR REACTOR PRESSURE VESSEL FOR 100-MWt OPERATION. D. J. Roy and T. L. Kettles (Argonne National Lab., Ill.). p.537-56 of "Small and Medium Power Reactors. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

A description is presented of modifications to the EBWR plant pressure vessel which were effected during the period Oct. 1 to Nov. 24, 1959. The work described is unique in that vessel reconstruction was carried out after 8000 Mwd of reactor operation. The experience supports the conclusion that the EBWR is one of the most practical of all reactor types for electric power production. (J.R.D.)

**33029** IMPROVEMENTS IN OR RELATING TO NUCLEAR POWER REACTOR ARRANGEMENTS. Michael Carl Hartnell-Beavis (to General Electric Co., Ltd.). British Patent 878,701. Oct. 4, 1961.

A nuclear power reactor arrangement which is par-

ticularly compact and has maximum accessibility is designed for marine propulsion purposes. The arrangement comprises a highly rated gas-cooled reactor adapted for horizontal charge, discharge, and control operations, and a plurality of horizontally disposed vapor generating units. The housing is designed so that channels are accessible from either end. Some of the advantages of the arrangement are minimum shielding weight, minimum acceleration of control elements, maximum natural circulation of cooling gas, and lowest possible center of mass. (D.L.C.)

**33030 IMPROVEMENTS RELATING TO NUCLEAR STEAM GENERATORS.** Winnett Boyd (to Winnett Boyd Ltd.). British Patent 879,184. Oct. 4, 1961.

A nuclear power station utilizing a gas-cooled reactor is designed which can be operated at higher temperatures while requiring no thermal expansion joints in the reactor gas ducts. The improvement is effected by surrounding the pressure vessel, steam raising unit, and ducts with cooling water and insulating their internal surfaces with commercial carbon. The design also permits hydrostatic testing of reactor components and provides safety in event of a break. (D.L.C.)

**33031 DEVICE FOR COMPENSATING THE EFFECTS OF VERTICAL ACCELERATION TO A BOILING WATER REACTOR, MOUNTED ON A SHIP.** (to Commissariat à l'Energie Atomique). French Patent 1,209,632. Mar. 2, 1960.

In order to compensate the influences of density variations in the water-steam mixture in the core of a boiling water reactor mounted on a ship, these variations being caused by vertical accelerations, the flow of the liquid through the reactor is regulated. The compensating device controls the opening of a by-pass of the pump provided to make the liquid circulate through the core, so that this opening is increased in the case of an acceleration in an upward direction and vice versa, with the production of an alteration (a reduction or an increase, respectively) in the circulation. Preferably a regulating mass is supported by elastic means so as to be movable in a vertical direction, this mass being connected with an organ controlling the opening of the by-pass. Suitably a second mass with an elastic support ensures a lead of phase of the circulation relative to the phase of acceleration by controlling the opening of the by-pass by means of a second control device connected with this second mass. For this purpose the movement of the second mass is damped by an adjustable device. (NPO)

**33032 NUCLEAR ROCKET.** (to Etat Francias). French Patent 1,215,729. Apr. 20, 1960.

The propellant of a nuclear rocket passes through the parallel channels of the core of a reactor after being preheated by the thermal radiation emitted by heated propellant. The reactor core comprises a great number of zones of molten fuel (uranium carbide or plutonium etc.); these zones are enclosed in hollow graphite bars constituting the moderator. The cross sections of each of these fuel zones are small in order to increase the heat exchange, and the reactor core shows a quasi-homogeneous structure. An absorbent (lamp black etc.) is added to the propellant in order to increase the absorption of thermal radiation thereby. (NPO)

**33033 IMPROVEMENT RELATING TO STEAM PRODUCING INSTALLATIONS.** (to Rolls-Royce Ltd.). French Patent 1,219,888. May 20, 1960.

A nuclear reactor, moderated with heavy water, that is designed for superheating steam is described. The superheated steam delivered by the reactor is divided into a

first part fed to the turbine plant and a second part fed to a heat exchanger and a boiler. The water coming from the condenser of the turbine plant is preheated firstly by the heavy water of the moderator by heat exchange, further preheated in several steps by steam expanded in the different stages of the turbine plant, and finally fed to the boiler where it is evaporated by heat exchange with the superheated steam coming from the reactor. The steam developed in the boiler is then superheated in the heat exchanger and delivered to an injection tube axially positioned in the narrowest portion of a venturi tube. After giving up some of its heat to the water in the boiler, the steam coming from the reactor is also fed into the venturi tube. The two steam currents are mixed and expanded together in the venturi. The degree of super-heating is then reduced by injection of a part of the preheated condenser water, before it is fed again into the reactor. With this arrangement a circulation of the steam results without the need for steam blowers. (NPO)

**33034 ENRICHMENT PROCESS FOR NUCLEAR FUEL.** K. Diebner. French Patent 1,225,613. July 1, 1960.

An enrichment process for natural uranium consists in placing additional uranium inside the core of a reactor working with natural uranium or in surrounding this core by additional uranium, so that in place of the consumed uranium-235 an equivalent quantity of plutonium is produced. The uranium of the system enriched in fissile material, plutonium, then constitutes a mass able to form with ordinary water a working reactor. The advantage of this process is that fuel elements irradiated in such a reactor do not need to be processed but can be stored, for example, in a water tank and loaded finally into a ship's reactor functioning with ordinary water. The transfer of fuel elements to the ship's reactor may be performed through a flooded lock system. (NPO)

**33035 PROCESS FOR REMOVING THE HEAT DEVELOPED INSIDE A NUCLEAR REACTOR WITH PREPRESSURIZED MERCURY VAPOR AS COOLANT.**

K. Diebner. French Patent 1,225,614. July 7, 1960.

During the start-up of a reactor, liquid mercury is pressurized inside the cooling system by an inert gas; this gas circulates through the reactor and has a sufficient pressure to remove the heat developed. As the coolant temperature increases, the vapor pressure of the mercury increases and the proportion of mercury vapor in the coolant increases. Finally the vapor pressure of the mercury exceeds the pressure of the gas used to pressurize the mercury before the start-up, so that the heat removal in the reactor is almost entirely due to the mercury vapor. When the reactor is at full power, the mercury in the system has a temperature sufficient for it to remain in the vapor state in all parts of the system. (NPO)

**33036 IMPROVEMENTS RELATING TO PRESSURE TUBE REACTORS.** (to Société Française des Constructions Babcock & Wilcox). French Patent 1,227,433. Aug. 19, 1960.

In the described reactor, pressure tubes pass parallelly through the moderator container, each tube being closed at both ends by removable closure means. Each pressure tube is joined by connection tubes to entrance and exit header tubes connected to heat exchangers. The axes of the pressure tubes lie in a plurality of parallel planes alternately with the axes of the header tubes, and the header tubes are connected with half of the pressure tubes lying in each of the two adjacent pressure tube planes and in the same half of the reactor. The header tubes enter the heat exchanger parallel, close together, and extend in the



same direction as the pressure tubes, header tubes of the same plane thus forming a row. The other ends of the header tubes are bent in a right angle, the extremities of these end portions lying on a straight line parallel to the pressure tubes. The headers are extended at these extremities by the connection tubes, which are bent in a direction opposite to that in which the header tubes are bent, before being connected at lateral openings in the pressure tubes; as a result the unit formed by a header and a connection tube has a sinuous shape able to accommodate thermal expansions of the pressure tubes. (NPO)

**33037** PROCESS FOR RECOVERING THE HEAT DEVELOPED IN A NUCLEAR REACTOR, AND REACTOR DESIGNED TO MAKE USE OF THIS PROCESS. (to Deutsche Gold- und Silber-Scheidentalt Vormals Roessler). French Patent 1,227,647. Aug. 22, 1960.

A process is described for recovering the heat developed in a reactor, whereby the heat developed in the fuel elements is transferred to a cooling circuit partly or completely by radiation. The core of the reactor is positioned inside a containment shell, the outer wall of which is encircled by the tubes of the cooling circuit in such a way that the heat developed is transmitted to the shell and cooling tubes by radiation from the core. The fuel is in a liquid state during the reactor operation so that the fission products may form an easily removable slag-layer and the gaseous fission products may escape by passage through this slag-layer. According to another form the graphite moderator is impregnated with fuel. (NPO)

**33038** IMPROVEMENTS IN NUCLEAR REACTORS. (to Hawker Siddeley Nuclear Power Co., Ltd.). French Patent 1,229,345. Mar. 21, 1960.

A CO<sub>2</sub> cooled, heavy water moderated reactor in which the moderator tank is connected with a heavy water filled riser which is pressurized with CO<sub>2</sub> is described. The top of the riser is connected with two distillation columns, one of them containing an alkaline solution for continuously removing dissolved CO<sub>2</sub> and its transformation products from the moderator. (NPO)

**33039** NUCLEAR POWER PLANT AND OPERATING PROCESS FOR THIS PLANT. P. Maldague. French Patent 1,233,798. Oct. 12, 1960.

A nuclear power plant is described consisting of a nuclear steam generator and a normal superheater having a capacity corresponding to that which the generator is anticipated to reach. All the installations relating to the gas or fuel circuits are calculated for the maximum admissible overload. The steam leaving any superheater stage, with the exception of the last, is desuperheated by water injection before entering the following stage. The quantity of injected water is controlled, so that the temperature of the steam fed to the turbine remains constant. (NPO)

**33040** BOILING WATER REACTOR WITH SUPERHEATING. (to U. S. Atomic Energy Commission). French Patent 1,234,404. Oct. 17, 1960.

The boiling water reactor comprises a pressure vessel enclosing a core constituted by a plurality of vertically positioned parallel hollow fuel elements supported at their ends by support plate systems. The moderator water enters at the top of the vessel, via the upper tubular extensions of the fuel elements, flows downwards and becomes heated, and begins to boil in a lower region. The steam developed leaves the hollow fuel elements by lateral openings that are nearly tangential to the inner fuel tube wall. The steam is then superheated in the space between the fuel tubes before it leaves the reactor vessel. (NPO)

**33041** METHOD OF OPERATING NUCLEAR REACTORS. (to Shell Research Ltd.). French Patent 1,234,508. May 16, 1960.

A reactor in which the coolant consists of aromatic hydrocarbons, preferably benzene and/or its lower homologues or aromatic petroleum fractions, is operated under such conditions of pressure and temperature (more than 50 atm and 370°C will generally suffice) that the system is kept in the supercritical state. (NPO)

## Research Reactors

*Refer also to abstract 32283*

**33042** (SGAE-61/3B) ARBEITSBERICHT UND VERSUCHSERGEBNISSE DES ASTRA-REAKTORS, JANNER BIS MARZ 1961. (Work Report and Experimental Results with the ASTRA Reactor, January to March 1961). A. Bruneder, A. Burtscher, H. Kratschmann, A. Nedelik, and F. Woloch (Österreichische Studiengesellschaft für Atomenergie GMBH, Vienna). 53p.

The work done on the ASTRA Reactor from January to March 1961, is reported. The effect of the thermal column on the excess reactivity of the 4 x 5 core arrangement was determined. The value obtained, 0.6% Δk/k, agrees well with theoretical values. Activity measurements on steel tubes C, D, E, and F showed that their effect on reactivity in flooded and unflooded states could be measured with a modification of the existing 4 x 5 core. The quadratic weight factor in core II was determined with standard elements poisoned with stainless steel strips. The void coefficients were also determined. The effect of the construction of the fuel elements on flux distribution and critical mass was studied. The magnitude of the flux increase in the water gap between bare fuel elements was determined, and from these measurements the effect on the thermal utilization factor was estimated. A criterion was obtained on whether the variation between the measured and calculated critical mass could be ascribed to the modification of the fuel elements. From the thermal flux measurements the linear and quadratic weight factors were determined. The ventilation system of the reactor building is briefly considered. The alterations made in the cooling system, primarily the heat exchanger and the secondary system, are reported. Measurements taken against corrosion in the steel tubes and to strengthen the reactor stack are reviewed. Calculations are shown in appendices. (J.S.R.)

**33043** REACTOR-PHYSICAL TESTS DURING THE COMMISSIONING OF THE EXPERIMENTAL ATOMIC POWER STATION AT KAHL. R. Misenta (AEG, Abteilung Kernenergieanlagen, Frankfurt am Main). Kerntechnik, 3: 392-8 (Sept. 1961). (In German)

The first step in the commissioning of the experimental atomic power station Kahl was the insertion of fuel elements into the reactor pressure vessel, whereby the smallest critical arrangement of the fuel elements was built up. After measurements of the blister coefficient and of the temperature coefficient of reactivity, and tests of the reactivity efficiency of the steel boxes, the complete core was inserted into the reactor pressure vessel. The charging of the fuel elements was interrupted for tests with 36, 48, 60, 72, and 84 elements. Among other things, the blister and temperature coefficient of the reactivity were measured in the full reactor core with 88 fuel elements, control rod withdrawal sequence and critical arrangements of the control rods were determined, and individual control rods gaged. The reactor-physical tests were performed at a power level in the kilowatt range,

that is in a power range of only about 0.01% of the full thermal reactor capacity of 60 Mw. Zero-power tests were performed. (auth)

**33044** BOILING NUCLEAR REACTOR WITH INTERNAL SUPERHEATING. (to Société Générale de Constructions Electriques et Mecaniques). French Patent 1,238,871. July 11, 1960.

The coolant and moderator tank of the boiling reactor is divided into three superposed zones: an upper vapor zone, and a middle and lower liquid zone, the latter two being

hermetically separated from each other. Hollow fuel elements which possess a bottom, a top, and a side opening extend from the bottom of the lower zone into the vapor zone; the side opening is situated just below the separating partition. Subcooled coolant is introduced into the middle zone, flows from there into the lower zone through an external connecting tube, and rises in the fuel elements where it is partly converted into steam. The steam is superheated in the top part of the fuel elements and the unevaporated liquid leaves the fuel elements by the side openings. (NPO)



# WASTE DISPOSAL AND PROCESSING

**33045** (CEA-1759) SOLIDIFICATION DE SOLUTIONS RESIDUAIRES CONCENTREES DE PRODUITS DE FISSION; ETUDES DE LABORATOIRE. (Solidification of Residual Fission-Product Solutions; Laboratory Studies). R. Bonniaud, P. Cohen, C. Sombret (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucléaires, Saclay). 1961. 25p.

A description is given of results obtained, at laboratory scale, during the study of the incorporation of fission products into glasses and synthetic micas. The rate of leaching of fission products from the glass and their volatility during firing were measured. (auth)

**33046** (DLCS-1690204) RADIOACTIVE WASTE DISPOSAL SYSTEM PERIODIC RADIATION MONITORING SURVEY. Test Evaluation (T-612075). Core I, Seed 2. Section 2. (Duquesne Light Co., Shippingport, Penna.). First issue, Oct. 4, 1961. 23p.

Tests were carried out to determine periodically the radiation level at all monitored points in the radioactive waste disposal plant and the effectiveness of shield facilities in working areas at times during which the radiation level is above limits set by Health Physics. The radiation surveys were made using radiation control instruments available on the site. Air samplings were made, as necessary, to reflect activity level changes which occurred during incinerator or drumming operations. The radiation control measures in effect during the period of test performance appeared to be adequate. No conclusion could be made as to the effectiveness of the shielding facilities in the work areas. (M.C.G.)

**33047** (HW-55963RD(Del.)) THE SELF-CONCENTRATION OF HIGH LEVEL PUREX WASTES IN THE HOT SEMIWORKS WASTE CONCENTRATOR. R. D. Dewitt and R. J. Sloat (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 12, 1959. Decl. with deletions July 14, 1959. Contract W-31-109-Eng-52. 28p.

Self-concentration phenomena of Purex waste in a Hot Semiworks tank were investigated. The tank was designed to simulate waste storage tank conditions likely to develop in the core of a 75-ft diameter Purex self-concentrating waste storage tank. The tank when filled with waste had a fission product heat generation rate of approximately 9000 Btu/hr. With continued boiling a layer of sludge developed on the bottom of the tank which contained a large fraction of the fission products. Bumping in the tank appeared to be a function of liquid level. (M.C.G.)

**33048** (HW-68193) RESEARCH AND DEVELOPMENT ACTIVITIES FIXATION OF RADIOACTIVE RESIDUES QUARTERLY PROGRESS REPORT, OCTOBER-DECEMBER 1960. D. W. Pearce, ed. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 15, 1961. Contract AT(45-1)-1350. 41p.

Progress is described in two types of fixation methods: high-temperature reactions (calcination processes) yielding either powders or coherent solids; and low-temperature reactions of ions in solution with ion-adsorption materials or other mineral reactants. Both laboratory and larger-scale studies are carried out. Plans are discussed for hot-cell experiments involving a small manipulator-handled spray calciner. The equipment is to be of flexible design, and is to combine spray-calciner and melt-pot, so that either system can be operated separately or both together. (T.F.H.)

**33049** (LAMS-2588) RADIATION MEASUREMENT OF THE EFFLUENT FROM THE KIWI-A SERIES OF REACTORS. H. S. Jordan (Los Alamos Scientific Lab., N. Mex.). June 29, 1961. Contract W-7405-eng-36. 128p. Includes Appendices: A. PROGRAM OF THE ENVIRONMENTAL RADIATION LABORATORY, UNIVERSITY OF CALIFORNIA AT LOS ANGELES. Kermit H. Larson. B. STATION EQUIPMENT LIST FOR INSTRUMENTED SECTOR.

A compilation of data documenting air and ground concentrations, particle size, and isotopic composition of the radioactive effluent from the Kiwi-A series of test reactors, together with descriptions of the sampling and analytical instrumentation are presented. Data are also presented on the indirect radiation from the reactor and radiation due to passage of the effluent cloud for two of the three reactors. A hazard evaluation, in which actual measurements are compared to applicable maximum permissible exposures, summarizes the data from each test operation. (auth)

**33050** (ORNL-3163) THE EFFECTS OF INTERNAL HEAT GENERATION ON POT CALCINATION RATES FOR RADIOACTIVE WASTES. J. J. Perona (Oak Ridge National Lab., Tenn.). Oct. 23, 1961. Contract W-7405-eng-26. 21p.

Methods by which the radial deposition mechanism was determined in experiments with simulated waste solutions are reviewed. Based on this mechanism, an expression for the rate of solid deposition with internal heat generation was developed by a combined heat and material balance. A sample calculation for Purex waste showed that a moderate heat generation rate of 5000 Btu/hr/ft<sup>3</sup> would decrease the time to fill a 12-in.-dia calcination vessel from 78 to 55 hr. For the calcination stage of the process, in which the deposited solids are heated in the absence of a liquid phase, a solution was developed for the equation of heat transfer with the temperature profile from the solid deposition stage as an initial condition. For the example Purex waste with a heat generation rate of 5000 Btu/hr/ft<sup>3</sup>, less than 15 min would be required for calcination, compared to about 8 hr in experiments with simulated wastes. (auth)

**33051** (ORNL-3192) EVALUATION OF ULTIMATE DISPOSAL METHODS FOR LIQUID AND SOLID RADIOACTIVE WASTES. PART II. CONVERSION TO SOLID BY POT CALCINATION. J. J. Perona, R. L. Bradshaw, J. T. Roberts, and J. O. Blomeke (Oak Ridge National Lab., Tenn.). Oct. 16, 1961. Contract W-7405-eng-26. 46p.

The costs of pot calcination of Purex and Thorex wastes were calculated. The wastes were assumed produced by a plant processing 1500 ton/year of U converter fuel at a burnup of 10,000 Mwd/ton and 270 ton/year of Th converter fuel at 20,000 Mwd/ton. Costs were calculated for processing Purex waste in acidic and reacidified forms and for processing Thorex wastes in acidic and reacidified forms and with constituents added for producing an acidic Thorex glass. Calcination vessel designs were right circular cylinders similar to those used in engineering development studies. Costs were calculated for processing in 6-, 12-, and 24-in.-dia vessels with a fixed length of 10 ft. Vessel costs used, based on estimates from private industry, were \$500, \$855, and \$2515 each for the three sizes. Costs were calculated for wastes decayed 120 days and 1, 3, 10, and 30 years after reactor discharge prior to calcination. Aging had negligible effect on costs, except as it permitted larger diameter vessels to be used, because vessel and operating



costs were much larger than capital costs in all cases. The lowest cost was  $0.87 \times 10^{-2}$  mill/kwh<sub>e</sub> for processing acidic Purex and Thorex wastes in 24-in.-dia vessels, and the highest was  $5.0 \times 10^{-2}$  mill/kwh<sub>e</sub> for processing reacidified Purex and Thorex wastes in 6-in.-dia vessels. About 7 years of interim liquid storage would be required before acidic Purex wastes could be processed in 24-in.-dia vessels. (auth)

**33052** (TID-12383) REACTOR FUEL WASTE DISPOSAL PROJECT—PERMEABILITY OF ROCK SALT AND CREEP OF UNDERGROUND SALT CAVITIES. Final Report. T. D. Reynolds and E. F. Gloyna (Texas. Univ., Austin, Sanitary Engineering Research Labs.). Dec. 30, 1960. Contract AT-(11-1)-490, 140p.

A study was made of two problems of salt-cavity storage, namely, seepage of wastes out of formations and closure of cavities due to plastic flow of salt. The results indicate that both problems are negligible; bedded salt is more impermeable than dome salt. Kerosene was found to be nonreactive with dome salt whereas brine solutions showed some interaction. It is concluded that storage of radioactive wastes in salt cavities is feasible. (D.L.C.)

**33053** A COMPARISON OF OBSERVED PLUME RISES WITH VALUES OBTAINED FROM WELL-KNOWN FORMULAS. Harry Moses (Argonne National Lab., Ill.) and Gordon H. Strom (New York Univ., New York). J. Air Pollution Control Assoc., 11: 455-66 (Oct. 1961).

The height to which a stack effluent will rise in the atmosphere is of importance in calculating the resulting concentrations at ground level. Six formulas are compared with experimental stack data in order to test their validity. The formulas are those of: Holland; Davidson and Bryant; Sutton; Scorer; Carey, Bosanquet, and Halton; and an additional one by Bosanquet. There is no one formula which is outstanding in all respects. The nature of the problem influences the selection of the formula. The formulas of Sutton and Bosanquet are not recommended. (N.W.R.)

**33054** TRAPPING FISSION PRODUCTS IN THE HTGR. R. M. Watkins, D. D. Busch, and L. R. Zumwalt (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nuclear Eng., 6: 427-8 (Oct. 1961).

The use of silver and copper-coated charcoal and cesium impregnated charcoal for trapping or removing radioactive iodine, strontium, and tellurium at temperatures up to 900°F from the fuel element purge gas system of the High-Temperature Gas-Cooled Reactor is evaluated. The experimental apparatus used for duplicating the operating conditions anticipated in the reactor is described and a schematic diagram of the system is presented. The method in which the trapping reagent (aqueous silver acetate or ammoniacal silver acetate) is prepared is described. (N.W.R.)

**33055** REMOVING RADIOACTIVE IODINE FROM GASEOUS EFFLUENT. J. F. W. Smith and R. H. A. Crawley (English Electric Co., Ltd., Whetstone, Leics, England). Nuclear Eng., 6: 428-30 (Oct. 1961).

In a previous paper by Geldart the problems involved in removing iodine from reactor circuit gas streams were discussed and various adsorbents evaluated. Here, the particular problems involved in civil reactors of the Calder type are dealt with and experiments described in which tests were carried out with carbon, copper, bronze, and silver adsorbents. (auth)

**33056** WASTE CONTROL AT THE GENERAL MOTORS RESEARCH, ISOTOPE LABORATORY. A. Somerville

(General Motors Corp., Warren, Mich.). Purdue Univ., Eng. Bull., Ext. Ser., No. 106, 341-50 (Mar. 1961).

Procedures are outlined for the control of wastes in an isotope research laboratory. It is pointed out that the success of a given system depends upon careful planning since waste control starts with the design and equipment of a suitable work space. All radioactive waste should be assayed by nuclear radiation detectors. Radioactive waste is usually a mixture of different radioisotopes and the nature of the mixture is seldom fully known. Chemical toxicity of the contents must also be considered. (C.H.)

**33057** DISPOSAL FOR RADIOACTIVE WASTES IN NATURAL SALT-FIELD EXPERIMENTS. W. J. Boegly, Jr., R. L. Bradshaw, F. M. Empson, and F. L. Parker (Oak Ridge National Lab., Tenn.). Purdue Univ., Eng. Bull., Ext. Ser., No. 106, 577-90 (Mar. 1961).

Wastes from the reprocessing of spent nuclear reactor fuels constitute one of the most complex and hazardous effluents produced by any industry. Due to their fission product concentrations and chemical composition, these wastes generate heat by radioactive decay, are high-energy radiation sources, and are corrosive to most common metals. Preliminary results are reported from field experiments on the direct disposal of these radioactive liquids to cavities in natural salt formations in the Carey Salt Mine at Hutchinson, Kansas. Results indicate the temperature rise in the cavity will not be as high as predicted by theoretical calculations. Cases released from the large cavities had the same constituents as the gases from the scale models, and were handled successfully by the off-gas system. The increase in salt temperature resulted in an increased rate of plastic flow. (C.H.)

**33058** TEMPERATURE RISE WITHIN RADIOACTIVE LIQUID WASTES INJECTED INTO DEEP FORMATIONS. Herbert E. Skibitzke (Geological Survey, Washington, D. C.). Geological Survey Professional Paper 386-A. 1961. 11p. \$0.15(GPO).

Data and a method of analysis are presented to provide for an approximate determination of expected temperature rises. They show that, in general, when large masses of liquid waste are injected into an aquifer through wells, heat conduction is not very significant, and as an approximation the temperature rise within the aquifer, from the time injection began, is equal to the total heat generated in a unit volume of aquifer divided by the product of the specific gravity of the aquifer and contained waste and its heat capacity. (auth)

**33059** RADIOACTIVE WASTES. THEIR TREATMENT AND DISPOSAL. J. C. Collins, ed. London, E. & F. N. Spon Ltd., 1960.

The nature of radioactivity, sources of radioactive wastes, hazards of radiation, measurement of radioactivity, legislation controlling radioactive wastes in Great Britain, treatment of liquid radioactive wastes by chemical and biological methods, and disposal of liquid, solid, and gaseous radioactive wastes are discussed by various authors. Bibliographies are appended to each chapter and a glossary of terms is included. (Public Health Eng. Abstr., 41: No. 9, 1961.)

**33060** GROUND DISPOSAL OF RADIOACTIVE WASTES. (to Continental Oil Co.). French Patent 1,235,240. May 23, 1960.

Subterranean non-porous rock formations at a depth of 15 to 6000 m are ruptured in a horizontal direction according to conventional techniques. Non-porous strata between successive fractures should have a thickness of



at least 1.5 m. Radioactive liquids are disposed by injection into these fractures under a pressure which is high enough to rupture the rock further, care being taken that the fractures do not extend into non-porous strata. Finally the injection hole is closed. (NPO)

**33061** RIGID CONTAINER THAT IS RESISTANT TO HIGH EXTERNAL PRESSURES. (to Société Générale d'Exploitations Industrielles). French Patent 1,235,562. May 30, 1960.

A composite container for the marine disposal of radioactive waste consists of an inner flexible bag for holding the waste and an outer rigid container. (NPO)

**33062** TIGHT AND RIGID CONTAINER THAT CAN WITHSTAND HIGH EXTERNAL PRESSURES. (to Société Générale d'Exploitations Industrielles). French Patent 1,236,050. June 7, 1960.

Cylindrical metal or polyethylene containers with corrugated walls or ends, which can be used for the marine disposal of radioactive waste, are described. (NPO)

**33063** METHOD OF CONCENTRATING AQUEOUS SOLUTIONS OF RADIOACTIVE WASTES. (to U. S. Atomic

Energy Commission). French Patent 1,246,368. Oct. 10, 1960.

Liquid radioactive wastes which contain aluminum nitrate are concentrated and solidified by atomizing into a vertical fluidized bed of  $Al_2O_3$  particles (particle size 0.074 to 0.84 mm) heated to 400°C. The exhaust gas, consisting of the fluidizing gas and vaporous wastes, is filtered, partially condensed, and discharged into the atmosphere while the grown particles are discharged at intervals and stored. The fluidizing gas should consist of CO, if desired, mixed with  $N_2$ . See also French Patent: 1.188.033. (NPO)

**33064** METHOD OF ELIMINATING RADIOACTIVE WASTES AND PRODUCTS THAT ARE OBTAINED ACCORDING TO THIS METHOD. (to Commissariat à l'Energie Atomique). French Patent 1,246,848. Oct. 17, 1960.

Moist radioactive sludges are solidified by mixing 100 parts with 110 to 140 parts Portland cement and 1 to 3 parts sodium silicate. The solidified mass is coated with a polymerized resin, bitumen, or sodium silicate to increase the retention of the radioactive substances. (NPO)

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